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[656]

Competition by roads, waterways and airways.

II.

Owing to the need for co-ordinating the different methods of transport, regulative measures have had to be taken in several countries, either by means of administrative decrees or by modifications to existing legislation.

Below we give information on this subject, supplied by the Portuguese Railway Company, the Royal Hungarian State Railways, as well as a decree relating to the co-ordination of transport in French West Africa.

PORTUGAL.

Portuguese Railway Company.

The information given below has been taken from a communication from the Portuguese Railway Company. It relates to measures taken on the one hand by the Government, and on the other by the Company itself.

Governmental measures.

In April 1932, the Portuguese Government appointed a Commission to find a basis upon which the different methods of transport could be co-ordinated so that they might be complementary, one to the other, and harmful competition might be avoided. At the same time the Commission was to devise a formula for combined routes, timetables, and rates, which would best serve the national economy.

This commission included representatives of : the railway companies, the road hauliers, the Government Railway Department, the Higher Transport Board, the Automobile Club of Portugal, the Road Board, the Port of Lisbon Authorities, and the Post and Telegraph Department, as well as the War Office, which also is concerned with the means of communication.

As the result of the report presented by this Commission, the Portuguese Government issued on the 22nd June, 1933, an order entitled : « Regulations dealing with transport by heavy motor vehicles and the co-ordination of such transport with rail transport », subsequently revised on the 24th January, 1934.

The preamble to the above mentioned regulations states :

In such co-ordination, the essential object is to define the fields of action proper to each method of transport, by facilitating the

setting up of motor services and their extension whenever they form a link between the districts they serve and the railway, or when they give a definitely superior service, at the same time discouraging such services whenever the result would be commercial competition with the railway to the detriment of the Nation.

The regulations divide transport by heavy motor vehicles into two classes: *private* and *public*. These latter, the only ones to be considered, may be : public (in common), or hire, the latter term applying to those services in which the vehicles are hired as a complete unit, for their seating capacity in passenger services, or their loading capacity in the case of goods or parcels, for the exclusive use of the hirer wherever he may want to go.

The public services, which have to work to published timetables and rates over known *routes*, are divided up into *regular* and *occasional*, these latter lying outside the scope of the regulations because as they are intended to develop economically districts not justifying a regular service, and as they are only allowed to operate five days a month, they cannot be considered as competing with the railway in any way.

The *regular* lines, i. e. those which are operated regularly and frequently over the same route in virtue of a permanent concession, are the only ones we need consider. These lines can be divided into two classes : *independent* when they do not affect the railway financially because they link up districts which the latter either does not serve or where the rail journey is much longer, and *interfering*, when they affect the railway financially and commercially, favourably or unfavourably.

In a general way, when there is no proof to the contrary, all services in districts outside a 10-km. (6.2-miles) zone on each side of the railway are classed as *independent;* and all those which work a route mileage of more than 100 km. (62 miles) as *interfering* lines.

The *interfering* lines, therefore, are the only ones to be considered. The Regulations divide them into : *feeder* lines, *complementary* lines, and *competing* lines.

The first link up districts without railway facilities to the nearest station; the second are lines set up on the initiative of a railway company in order to handle the traffic by road between the ends of a section of the railway on which the company has suspended all train workings or has reduced them by at least 20 %; finally, in a general way *all lines* are considered as being *in competition* which are *not independent, feeder or complementary* lines, and in addition those which link up localities directly served by the railway when the length of the rail journey is not more than double that by road, and those which, while connecting localities not served directly railway, have a route mileage longer than that by rail.

The classification given above does not imply in any case a prohibition against the establishment of such services, but has the object of making clear the conditions these latter must comply with as regards the taxes they must pay and the extension of their activities.

In the case of *regular* lines there is no monopoly, anyone being free to operate such lines, but subject to their obtaining a concession from the Ministry of Public Works and Communications.

Such lines are only authorised when the following conditions are complied with :

a) the requirements of the Highway Code

must be fulfilled as regards vehicles and staff;

b) the services have to be run the full period of the concession, which is granted for five years, and then can be extended. They must be guaranteed by the deposit of securities or by a bank guarantee which the depositor forfeits if he ceases to operate the service without justification;

c) the approved timetables, rates, and other conditions laid down in the concession must be rigorously complied with by the concession holder.

Depending upon the classification of the lines, the concessions are granted subject to the conditions given in the following table :

Classification of the lines.	Timetables.	Cartage tax.	Carriage of goods.	Rates. Passengers minimum.	Rates. Passengers maximum.	Rates. Goods.
ndependent :	Free to fix times.	50 % reduction.	Free.	Equal to 3rd-class rail fare plus 10 %.	Equal to 1st-class rail fare.	Minimum scale per tonne-kilometre.
'eeder :						
) Joint service with the railway.	The timings connecting with the trains have priority.	60 % reduction.	Free.	Equal to 3rd-class rail fare plus 10 %.	Equal to 1st-class rail fare.	Minimum scale per tonne-kilometre.
) No joint service with the railway.	Free choice of available timings.	50 % reduction.	Free.	Do.	Do.	Do.
'omplementary :						
) Passenger service.	Priority to timings connecting with rail services.	60 % reduction.	—	Freedom to fix rates provided they are not below the minimum or above the maximum general rates on the railways to which they are complementary.		—
) Goods service.	Do.	Do.	—	—	—	Rates per tonne-kilometre not above those of the railway concerned.
'ompetitive :	Free choice of timetables.	Full tax.	Forbidden (except for small parcels up to 15 kgr. with a maximum of 80 kgr. per vacant seat).	Equal to 3rd-class rail rate plus 10 %.	Equal to 1st-class rail rate.	—
n the case of lines which may be operated *occasionally*.	—	Full tax.	Not allowed.	Equal to those of the independent lines.		—

Before a concession to operate *regular* lines is granted, the Administration holds an enquiry into the need for the proposed service, careful account being taken of the interests of those lines already in existence in the district concerned.

By this means it is hoped to avoid having too many lines in the more prosperous and more highly developed districts, and at the same time to encourage the introduction of lines in the poorer and more backward districts.

In the case of concessions for *competitive* lines, services introduced by the railway companies responsible for the railway services in the same district will be given first preference and after them concession-holders already operating the routes concerned, provided they make application before the enquiry closes.

The timetables of the *regular* services are drawn up or altered by the Road Transport Department which decides in particular the intervals between the departures of two following vehicles over a given route.

The rates must be approved by the Road Transport Department and must lie within the limits in the table given above.

All motor vehicles intended for public traffic and for hire have to satisfy the requirements of the Highway Code as regards safety and suitability, and have to be submitted for official inspection; this takes place whenever the Road Transport Department thinks fit, but at intervals of not more than six months.

The maximum dimensions of the vehicles, the minimum space per passenger, the accessories with which the vehicles must be fitted, the method of calculating the number of places, and the markings of the vehicle are laid down in the regulations.

The regulations also deal with the physical condition and technical knowledge required of the drivers, the medical examinations they must undergo, etc., etc., and finally the penalties to be imposed for any infringement of the regulations, penalties which, according to the case, consist of fines, or the use of the vehicle may be prohibited or it may be confiscated.

The *regular* services are obliged to carry the mails, payment being made by the Post Office for this service which does not interfere with the timetables.

Occasional services as a rule will be worked by the concession-holders of *regular* services.

Another decree (No. 23 498 of the 24th January, 1934) published conjointly with the regulations with which we have been dealing, revises the regulations on the payment and imposition of the transport tax, as the old regulations had been found unjust and ineffective.

Thus the transport tax, paid by all services carrying either passengers or goods, is based on the number of places or the carrying capacity of each vehicle, the number of kilometres of the route covered, the number of journeys made monthly and the minimum rates, all of which factors are known: the first three from the terms of the concession, the fourth being constant for each class of lines.

Under these conditions the transport tax is applied in accordance with the two following formulæ:

Passenger services:

$$\text{Tax} = 0.04 \times \text{T min.} \times l \times (p \times n);$$

Goods:

$$\text{Tax} = 0.04 \times \text{T min.} \times c \times (p \times n),$$

in which

T min. = the minimum rate per passenger-kilometre or per tonne-kilometre, in escudos;

l = the average number of seats in the vehicles on the lines in passenger service;
c = the average capacity of the vehicles used on the lines in goods service;
p = length of a single run over the line;
n = total number of single journeys per month.

In the case of *complementary* lines, T min. is taken as one escudo when calculating the tax.

In addition to the transport tax, motor vehicles are only required to pay the industrial tax and the sums charged for licences and other formalities.

Measures taken by the Portuguese Railway Company.

a) *Cartage contracts.*

Up to the present, the Company has not run its own motor services, but has limited itself to making contracts for this work with road hauliers. At the end of 1933, such services covered 738 km. (459 miles) by road, linking up 38 railway stations located in 72 localities.

A modification in the terms of the contracts was, however, felt to be necessary and it has been decided that all future contracts shall be based on the following points:

— Contract cartage services shall be considered as railway lines which connect and hand over their traffic to the railway stations;

— the respective road hauliers shall bear the same legal responsibilities towards the public as the railway;

— the chief offices of such firms shall be worked on the same lines as railway stations and be under the control of the Company;

— these firms shall not set up any service without the authorisation of the Company;

— the number and design of the vehicles, as well as the rates and timetables shall be established in agreement with the Company;

— the road hauliers shall act in the districts they serve as consignors or agents for grouped consignments of express parcels traffic;

— the same firms shall be obliged to put vehicles at the disposal of the Company at the stations of the district, as required or for excursions organised by the Company, or to facilitate the movement of passengers or goods when there is an exceptional rush at certain places;

— the firms shall be likewise required to take the place of steam-worked services on any sections the Company considers advisable, whether such working is from junction stations for places also served by rail, or of sections of line on which the railway services have been suspended;

— the firms shall act as subsidiaries of the Company;

— the firms shall be obliged, in addition, to introduce through services with the railway companies of the continent and with the cartage agencies in connection therewith as the Company requires.

As compensation for these obligations the firms are granted:

— The necessary technical assistance in organising their office and control services;

— full payment of their proportion of the charges for combined services without any reduction;

— reduction on the transport of containers.

As for the *door to door* services, which are also worked by cartage firms, these are considered as an extension of the railway and consequently outside the scope of the central collecting offices; the concession-holders are, however, subject to the same obligations and enjoy

the same advantages as the above mentioned firms.

b) *Passenger traffic.*

The following are some of the improvements made in passenger traffic working:

— The introduction of through passenger tickets with facilities for registering luggage through to stations on other railways;

— improved timetables;

— the issue of workmen's weekly season tickets made easier;

— increased services to watering places and spas (with further reductions in fares), week-end tickets and special tickets (fairs, markets, etc.); holiday trains, mystery trains, winter sports, excursion trains, introduction of new return tickets, etc.

— introduction of *popular* express trains on Sundays.

c) *Goods traffic.*

In the casee of goods traffic, mention should be made of:

— Bonuses in the form of rebates on an increasing scale granted to regular consignors of parcels traffic reaching given tonnages;

— the introduction of through express and slow goods services;

— the speeding up of certain goods trains;

— the running of special express trains between Lisbon and Oporto;

— on various lines, the application of reduced rates for a minimum annual tonnage;

— in certain areas, the free return of empty packing cases;

— various reductions in rates, especially affecting slow goods traffic over short distances.

* * *

HUNGARY.

The information given below is taken from a communication from the *Royal Hungarian State Railways.*

Water competition.

In order to meet water transport competition the railways had recourse to rating measures : reduction of rates, and combined transport.

Air competition.

The railway issues return tickets and gives airway passengers facilities for continuing their journey by rail in the case of forced landings, on production of their airway ticket. There are also regulations concerning the combined luggage and goods traffic.

Road competition.

The 1930 Act, regulating public road motor services, did not come up to expectations. The law restricted the activities of road hauliers to a radius of 30 km. (18.6 miles) and this so stifled motor transport that the concession holders took steps to circumvent it. There was an increase in the number of firms making a legal pretence to be engaged on works cartage, and there was a great increase in horse transport for which no authority was needed.

The time, therefore, seemed to have come to enable the motor to make the most of its advantages as compared with the railway, while excluding it from all traffic working the latter can undertake economically. The only way to give each method of transport its own field of activity and the Treasury its full receipts is to divide up the traffic in this manner.

The Royal Hungarian Government made the State Railways responsible for drawing up the necessary regulations, as they had been given the monopoly of road motor transport between towns throughout the country, subject to the condition that the concession was operated by the road hauliers, federated for this purpose. In order to comply with the ministerial decree and to work the traffic, the owners of road motor lorries set up the « National Federation of Road Motor Hauliers ». The State Railways, as lorry owners, through their motor subsidiary the « Mavart », are members of the Federation. The State Railways have made a contract with the Federation, the private independent railways subsequently following suit.

The object of the contract is to foster the interests of both the railway and the road by organising the traffic between towns. This enables the Federation of Road Hauliers to share regularly in the goods traffic of the country, in proportion to the vehicles they own. It also enables them to maintain and develop the equipment needed for operating a fleet of road motors (garages, repair shops, petrol and oil pumps, etc.) without adversely affecting, by unlawful or irregular competition, the national interests, both financial and fiscal, tied up in the railways. The result has been that not only did the railway retain its traffic but it increased it.

A management committee composed of 3 delegates from the Railways and 3 from the Federation has been formed to control road motor transport.

The country has been divided up into seven traffic districts and district offices have been set up at the centre of each district, the place selected being, whenever possible, the operating headquarters of the railway. These offices organise the road motor services and control them in accordance with the instructions laid down as regards operation, service instructions and working methods, drawn up by the Executive Committee.

The Federation operates the motor services inside each district in accordance with the terms of the contract and the operating methods laid down. The Federation is required to transfer to rail goods for destinations outside the limits of the district. The transfer is made at the collecting stations shown in the detailed map attached to the contract. The Federation is paid proportionally to the costs of carrying the traffic for such consignments.

Collecting stations have been designated so that the wagons loading up the traffic can be despatched well loaded; in this way the wagons are made better use of and the costs reduced. Carriage by rail becomes cheaper and quicker and the railway is better able to compete with the road.

If the railway reduces the class of any station or closes it, or suspends the service on any line on account of the small volume of traffic, the Federation has to deal with the traffic when required to do so. As regards bringing this traffic to account, an arrangement is made in each case and lays down the credits due to the Federation from the Railways or vice versa.

In principle, the Federation takes no steps to attract rail traffic but rather to increase the latter by restoring to rail traffic which had gone to road. In such cases, the Federation is paid a commission provided it is a question of « recaptured » rail traffic. This traffic is handed over to the railway at the collecting stations and also at all other stations open to goods traffic; as soon as it is handed over

it is dealt with just as ordinary consignments by individual consignors.

The Federation is obliged to keep the railway fully informed of any steps taken to obtain traffic.

The Railway Management controls through its headquarters and station staff the regular and *bona fide* working of the traffic by the Federation. The control service is expected in particular to see that the Federation does not divert traffic from the railway.

The number of contractors and firms affiliated to the Federation at its formation was 110 and is now 500.

Road motor transport can now only be operated in the spirit of the contract. The hauliers can only undertake to work traffic on behalf of the Federation, although retaining their independence, and by conforming with the terms of the contract and the operating plan. The operating responsibility is laid on the Federation vis-à-vis the consignors and the railway; the Federation is legally responsible and not the affiliated member who does the work nor his agent. The Federation also is held responsible for any errors committed by its members and is required to see the latter work to the operating instructions in force. The affiliated members are not allowed to undertake cartage work except through the Federation.

When goods in through traffic are lost either partly or wholly, or damaged, the party in whose possession the goods were at the time the damage or loss occurred is responsible If the place and time cannot be ascertained the railway and the Federation share the cost in equal parts.

The policy of both the Federation and the Railway as regards rates is to defeat competition by transport outside the Federation. The Federation has fixed minimum rates and is alone able to grant any reductions. The rates — for traffic between towns — is based on the actual distance covered when the charge is for the full vehicle load.

The Ministry of Commerce supervises the Federation and its members and in addition has to see that both the Federation and its members have equipment and staff available to meet their contractual obligations.

In order to check the regular working of the traffic, a waybill is used for each service and a separate consignment note is filled in for each consignment.

The members of the Federation generally operate freely inside each district. In some cases, owing to the opposition of the railway, certain traffic cannot be carried by road even inside a district; on the other hand the railway has agreed to other kinds of goods being carried by road without regard to the boundaries of the districts.

When so required by the Federation, the railway transfers to the Federation, for conveyance by road, consignments with waybills marked « by rail », which cannot be worked economically by rail.

This measure is economically an important one from the national point of view. By making return loads available for the lorries, mainly employed in carrying agricultural produce to Budapest, the working of the lorries is more profitable and the cost lower.

For the moment, the railway is only handing over to the Federation, and to a limited extent, consignments received at the Budapest stations.

The lorry drivers have to apply for return loads to the Budapest District Office, the staff of which makes the necessary arrangements.

As the new organisation has not yet proved itself, the contract is for three years. If it does not meet requirements

either party can withdraw from it during the period on giving 6 months notice. The contract only affects public road transport, as works lorries dealing with works traffic are not in any way affected by the present law.

Similarly the sole right to operate road transport and the contract do not apply to passenger traffic which will continue to depend upon a concession in each case. It should be noted that the Government only grants such concessions after having consulted the railways concerned.

FRENCH COLONIES.

French West Africa.

Decree dated 23rd January, 1934, regulating road motor transport in French West Africa:

Article 1. — An authorisation issued in accordance with the terms of the present decree is required before any road motor service either for passengers or goods can be operated in French West Africa over the public roads.

The term « road motor service » applies to all public services commercially operated for carrying passengers or goods, whether regular, i. e. working under published conditions, or occasional, i. e. when demanded by the public.

Orders issued by the Governor General in accordance with the spirit of article 3 below, can require certain classes of private transport to obtain authorisation under the same conditions as public services.

Article 2. — This authorisation is only granted after the need for the new service has been considered, and is issued by the Governor General or by the Lieutenant Governors under the conditions laid down by the Governor General's decree.

By decree, the Governor General can issue the authorisation subject to certain special requirements and guarantees in order to prevent or make good damage to the users, staff, or third parties, or to public property (structures, roads, etc.). Such guarantees may be either insurance policies with approved companies or deposited securities.

The authorisation gives particulars of the passenger, goods, or joint services, whether regular or occasional, and of the general arrangement of the vehicles.

In the case of regular services, the routes over which the service may be worked are specified and the vehicles may not be allowed to stop for business purposes in certain sections. The number of vehicles, the timetables, and the maximum rates are also given.

The authorisation has a clause fixing the period of validity which in no case can exceed 5 years.

Article 3. — In order to ensure better co-ordination of rail and road communication, special taxes varying in accordance with the co-ordination looked for and imposed according to the methods of taxation in force in French West Africa will be imposed on road motor operators, so as to assist in developing services acting as feeders to the railways. The proceeds of this tax will be included in the General Budget.

Article 4. — Any owner of a motor vehicle engaging in commercial passenger or goods work without authority or without having paid the dues will be subjected to a fine of 100 to 5 000 francs and if the offence is repeated, the vehicle may be confiscated.

The regulations in force dealing with the collection of indirect taxes in French West Africa are legally applicable to the collection of this tax.

Article 5. — Operators of road motor services set up before the present decree came into force must, within three months from a date to be fixed by the Governor General, make formal application for the authorisation provided for in article 1 above.

Any restriction this authorisation may impose upon the former operating conditions through the application of the above clauses will not entitle the operator to any compensation.

Article 6. — The Governor General will issue ordinances defining the method of application of the present decree.

[656. 222.1]

Note on Train Speeds,

by Lionel WIENER,
Professor at the University of Brussels.

PART II *(Continued).* (1)

Train speeds and services in different countries.

III. — THE INTERNATIONAL SLEEPING CAR COMPANY.

This Company has very largely contributed to the establishment and development of the great European express trains, and itself owns rolling stock to the extent of two thousand saloon coaches, so that it is only right to devote a special study to it, such as will be necessary for other similar organisations.

Their number is, however, somewhat restricted as the *International Sleeping Car Company* has been able to obtain an almost complete monopoly of this traffic in Europe, like the *Pullman Co.* in America.

CHAPTER XVII.

General matters.

XVII-1. — **Sleeping cars and dining cars belonging to other Companies.** — Apart from a few railway companies there are not more than half a dozen organisations which operate systematically this special rolling stock :

a) The American *Pullman Company* endeavoured, in 1870, to establish itself in England and later on in Italy, where the *International Sleeping Car Co.* had not penetrated as yet. Its English rolling stock was bought by the *Midland Ry.* and the *L.B.S.C.* when the contract expired, and the *International Sleeping Car Co.* absorbed the Italian services in 1886;

b) On the other hand, an English *Pullman* Company became flourishing, while the only endeavour of the *International Sleeping Car Co.* to establish itself in England failed in 1889. By a tacit « gentlemen's agreement », the *International Sleeping Car Company* does not interfere with the English services and the *Pullman* Company does not concern itself with the Continent. Recently, however, the *International Sleeping Car Co.*, as a result of a financial reorganisation, has bought a considerable interest in the English Company. This has given rise to the Continental Pullman services, and sleeping car services by train ferry between England and the Continent will probably be established;

c) After the 1st January, 1887, the *Prusso-Hessian* Railways, which dit not renew the expired contracts, themselves

(1) See *Bulletin of the Railway Congress*, October and November 1933, pages 885 and 1027; January, May and June, 1934, pages 63, 407 and 561 respectively.

operated sleeping-car services up to the War.

In addition to this a German dining car company, the *Deutsche Speisewagen-Gesellschaft* was founded, in which the *International Sleeping Car Company* had an interest (1). This rolling stock together with additional stock seized from the *International Sleeping Car Co.* formed the first operating material of the *Mitteleuropaische Schlaf- und Speisewagen A.G. (Mitropa)* which is still in existence;

d) In Switzerland, certain dining-car services are operated by the *Swiss Dining Car Company,* while others are directly operated by the *International Sleeping Car Co.;*

e) The Russian Empire transferred to this latter Company the working of its « de luxe » stock (1898). In the same way, the *International Sleeping Car Co.* works the buffet cars of the French Companies, as well as the restaurants and sleeping berths on the steamers of some navigation companies.

In Continental Europe, the Scandinavian States alone have always operated their own sleeping-car and dining-car services, just as the English Railway Companies have always done. Russia has done the same since the Revolution.

XVII-2. — **Timetables.** — We have taken the information given below from the *International Sleeping Car Co's.* timetables for the 1933/1934 Winter (2).

In the *sketch maps* showing the routes of the great expresses, we have represented :

by a thick continuous line — the present run;

by a thin continuous line — the additional run made by sleeping cars included in the important trains for part of their journey only;

by a dotted line, thick or thin — the obsolete routes of great expresses, or subsidiary branches.

All these maps (with the exception of figs. 96 and 100) are drawn to the same scale, 1 : 1 800 000.

XVII-3. — **The terminal stations.** — When studying the isolated services, a difficulty which it has not always been possible to overcome is met with : that of making the utilisation of the stock completely coincide with the requirements of special clients, when it is included in trains intended to meet much more general conditions. It is not enough for a dining car to run between two places at some meal time; it must be possible to use it on the return journey. The sleeping cars must likewise run in both directions during the night.

Although it is usually possible to make the various interests concerned coincide, as it is to the advantage of the railway administrations to include dining and sleeping cars in their trains, it is not always possible to avoid light running with such stock, and certain sleeping-car services, for example, terminate at stations which are different on the outward and return journeys.

Many of the « de luxe » trains and services from Paris or from Brussels to Calais return via Boulogne or vice versa,

(1) In 1914, it owned 1 256 shares in this Company.

(2) The following information will make it easier to read pre-war timetables:

The time in Spain was 5 minutes later than in Paris, and in Portugal 45 minutes.

Belgium, which had already adopted Greenwich time, was like England 7 minutes in advance of Paris.

Holland was 15 minutes in advance, the countries of Central Europe and likewise Switzerland, Italy and Serbia 55 minutes in advance.

Russia was 1 h. 56 m. in advance and all the Balkan countries 2 h. 8 m.

which in each case necessitates 44 km. (27 miles) of light running and applies in this case to complete trains.

XVII-4. — **Seasonal trains.** — Formerly many trains were only run during the Winter and others only during the Summer. The trains to the Riviera came into the first category, and it was to make use of the stock of which they were composed that the first « Calais-Suisse Express » was introduced. Since the introduction of Winter sports in Switzerland, and of a Summer season in the South of France, the difficulty of making full use of the stock has greatly decreased.

XVII-5. — **Names of towns.** — The *Sleeping Car Co.* has come to the excellent decision to retain the names of towns in their own language, the more so as the changes introduced during and since the War made this almost indispensable.

It would be a good thing to generalise this measure, as very few towns have different names in different languages. Thus there are only some half dozen French or English towns, nearly all of them ports, which have distinct names in the two languages :

Dover — Douvres.
London — Londres.
Edinburgh — Edimbourg.
Dunkirk — Dunkerque.
Havre — Le Havre.

and not many more in Belgium or Holland :

Brussels — Bruxelles.
Antwerp — Anvers.
Ghent — Gand.
The Hague — La Haye.
Flushing — Flessingue.

The pronunciation of these names, luckily, does not concern us, for how should one pronounce such English names as Worcester, Hythe or Warwick, or Welsh names, such as Aberffrwd, Amlwch, Cwnffrwd, Blaenplwyf, Bettws-y-Coed, even if they are not as long as the longest:

Llanfairpwllgwyngyllgogerychwyrndrobwllllantysiliogogogoch.

Latterly it has become the deplorable fashion to add, to the name of a station, that of a neighbouring place such as :

Saint-Gervais-Le Fayet-les-Bains.
Chambery-Challes-les-Eaux.

We have dropped the second part of these composite names, except in the case of twin towns like Budapest or Mézières-Charleville.

Note must be taken of another essential difference in the current practice in French and English. Hythe Jn. means in England that the station concerned is the junction for the branch line which goes to Hythe. On the Continent a similar name would mean a junction at Hythe.

XVII-6. — **Creation and development of the services of the International Sleeping Car Company.** — During a voyage to the United States, Mr. Georges Nagelmackers, an Engineer who graduated from the Liége School of Mines, remarked how the establishment of sleeping-car services was facilitated by the fact that these coaches belonged to a special organisation which was better able to negociate with the different administrations concerned than they would have been able to among themselves. Now at that time in Europe not only were the railways divided up into too many companies, but the political frontiers also complicated matters still further.

Consequently, Mr. Nagelmackers resolved to introduce services similar to those he had seen in America, but the War of 1870 hindered his plans and prevented

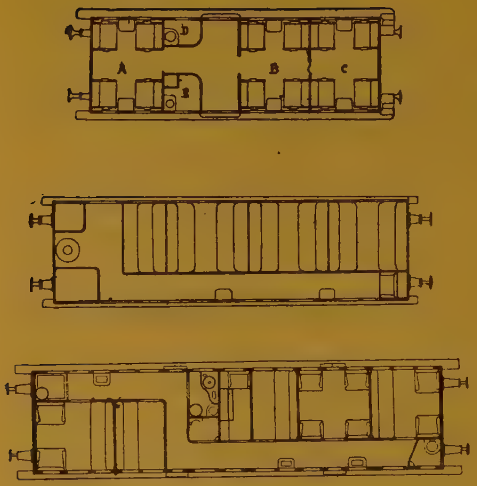

Fig. 66. — The first « voiture-lits », 1872.
1873. First sleeping cars with transverse berths, 4 and 6-wheeled.

These diagrams and those hereafter drawn to the same scale, were lent by the *International Sleeping Car Co.*, and some and them are taken from an old notice of the Company, reproduced by the *Revue Générale des Chemins de fer.*

him from putting his contracts into execution. When the War was over, he found a valuable supporter in King Leopold II and his Government and he was able to sign new contracts for working sleeping-car services in the « Malle des Indes » which, from the outbreak of the War, had been sent via Ostend and the Brenner and connected with the Bombay liners at Brindisi. Although the rolling stock had been ordered, the scheme had once more to be adjourned, since the construction of Mount-Cenis tunnel once more made the French route the best. The route via Ostend was given up (1) and the coaches ordered were used for services between Paris and Strasbourg, and between Ostend and Vienna.

(1) The name « Malle des Indes » (Indian Mail) or « Malle » was kept and is still used im Belgium for express trains between Ostend and Basle.

In 1873, Georges Nagelmackers formed in Liége the *Sleeping Car Company* with a capital of 500 000 francs, for which he soon substituted the *Mann's Railway Sleeping Carriage Co., Ltd.*, in which English capital was invested (fig. 67). This developed rapidly and within three years contracts were made with 21 Companies for periods varying from 3 to 20 years.

In order to accelerate the development of his scheme, Nagelmackers founded in Brussels, on the 14th December 1876, the *Compagnie Internationale des Wagons-Lits (International Sleeping Car Company)* with a capital of 4 000 000 francs and the *Mann* Company was wound up.

The rolling stock then consisted of 58 vehicles, and the new Company set up its first service between Paris and Mentone. This was a success from the start, and this line is still one of the best on the system. Not content with these encouraging results, the Company considered sleeping-car services from Calais to Brindisi and from Paris to the East.

At this period, its first dining cars were introduced to complete its programme, and by combining the two kinds of vehicle enabled complete trains to be made up entirely of *International Sleeping Car Company* stock, with dining cars, sleeping cars and vans. In order to express its aims more clearly it added to its name *« et des grands express européens » (and great European express trains).*

The first of these important trains, the « Orient Express » ran for the first time on the 5th June 1883. This was a subsidised mail train which shortened the journey from Paris to Constantinople by 30 hours.

From that time the Company considered a whole series of such trains. At the beginning the trains ran once a week, but the departures were multiplied according

Fig. 67. — « Voitures-lits » of the *Mann* Company.

to requirements. These trains ran twice, three times, and four times a week before becoming daily services.

Fig. 68.
1874. Sleeping car with one compartment fitted with ordinary seats.
1882. First dining car obtained by conversion of a 6-wheeled carriage.

On the 8th December 1883, the « Calais-Nice-Rome », always full in France, ran three times a week as far as Nice. A « Nord-Sud Express » was projected, from St. Petersburg to Lisbon via Berlin and Paris, with a connection from Brussels to Calais, when the dreadful cholera epidemic broke out which, beginning in Toulon in February 1884, soon spread to Marseilles and to Italy, to Spain the following Winter and to Austria-Hungary in 1886.

More than any other, a company of this kind was bound to suffer seriously from any economic upset, which in this case involved quarantine for all passengers, the stopping of all rolling stock at the frontiers, etc., All that could be done in the meantime was to make preparations for starting up again by improving the bogie vehicles and designing new trains.

The « Sud Express », proposed in 1884, was only inaugurated on the 5th November 1887; it ran twice a week from the

21st March following. The « Méditerranée Express », a twice-a-week train, was worked three times a week in 1886 and 1887 and four times a week in 1887/1888. In 1890 the « Calais-Brindisi » took the place of the « Malle des Indes » and the « Calais-Paris-Rome » was run for the first time.

Fig. 69.

1880. First experimental bogie sleeping car, built by the *Compagnie de Construction*.
1883. Bogie sleeping car and dining car of the « Orient Express ».

In the meantime, the Company continued to develop its powers by signing monopoly contracts with the railway companies. In 1885, contracts for 12 years were made with the *Est* and the *P.L.M.* Rys.; then a 15-year contract was made with the *Rumanian State Rys.*, and a 19-year contract with Portugal. In 1891, Austria renewed its contract for 20 years and, in 1896, the *Belgian State Rys.* signed the first contract for a period of 30 years.

And one new train after another came into being :

1st June 1894 : The « Ostend-Vienna », which was extended in 1885 to Constantza and to which was afterwards added a weekly portion to Triest (the « Triest Express ») and a Summer service to Carlsbad;

May 1896: the « Nord Express » from Paris and Ostend to St. Petersburg;

November 1897: the « Nord-Sud (Brenner) Express » from Berlin to Naples;

On its 25th anniversary (1898), the Company extended for the first time its activities outside Europe by setting up almost simultaneously services to Siberia (the « Trans-Siberian »), to Egypt (Alexandria, Cairo and Luxor) and, shortly afterwards, to Algeria and Tunis.

After the night expresses came the great day trains, necessarily over shorter distances, composed of saloon cars, a dining car and vans belonging to the Company.

The number of such trains increased rapidly up to 1914, as well as the isolated services, but then the activity of the Com-

Fig. 70.
1890. Large-type sleeping car and saloon-dining car for the *Paris-Orleans* and *Midi* Systems.
1901. Saloon car for the « Sud Express » and day trains (« Trouville Express », etc.).

pany was suddenly paralysed. The German and Austro-Hungarian services were lost, then those of the occupied territory of Belgium and Poland. When Turkey and Bulgaria came into the War and the occupation of Serbia and Rumania followed, its activities were still further limited.

Some of the French and Italian services were re-established after November 1914, and others survived up to the time of the Armistice which was actually signed in the Company's carriage, No. 2419, now preserved in the Invalides Museum, Paris.

The Russian services were not affected until the 1st February 1918, when they were definitely lost as well as the stock of 300 vehicles used for them.

At the end of 1918, the Company had resumed its monopoly contracts and was able to reorganise its services in Belgium, Rumania, Bulgaria, Turkey, Hungary and Austria. It signed other contracts on the same basis with the new States formed after the War : Poland, Czechoslovakia, Lithuania, Lettonia, Esthonia, Jugoslavia, and also established an incomplete *modus vivendi* with Germany.

After the Armistice the « Paris-Rome » was the first train to reappear, then the « Orient Express » over a new route, and the « Bombay Express ». The « Simplon-Orient Express », which since 1920 has linked up the allied capitals with those of the new States formed out of the Austro-Hungarian Empire and to the Balkan capitals, is also one of the immediate consequences of the War.

Finally the introduction of Pullman carriages and trains, after 1925, as well as sleeping-car trains, and still more perhaps 2nd and 3rd-class sleeping cars have in turn deeply altered the financial conditions under which the Company's services are carried out.

TABLE 110.

THE COMPANY'S GREAT EXPRESSES IN 1914.

Obsolete trains and services are shown in italics.

NAME OF TRAIN.	RUN.	Distance Km.	Distance Miles.	
Ægypten Express	*Berlin-Naples.*	1 956	1 215	Weekly.
Andalousie Express.	*Madrid At.-Sevilla.*	574	357	Daily. Winter.
Berlin-Marienbad-Carlsbad	*Berlin-Carlsbad.*	413	257	Daily. Summer.
	Eger-Marienbad.	30	19	Do.
Berlin-Rome-Naples-*Palermo.*	*Berlin-Taormina.*	2 466	1 532	Weekly.
	Messina-Palermo.	233	145	Do.
Bombay-Marseilles Express	Calais-Marseilles (Ar.).	1 178	732	Do.
Cabourg Express.	*Paris-Cabourg.*	274	170	Daily. Summer.
Cairo-Luxor Express	Cairo-Luxor.	674	419	3 t. a week. Win
Engadine Express	Paris Est-Chur.	731	454	Daily. Summer.
	Calais-Chaumont.	519	323	Do.
Lloyd-Riviera Express	*Berlin-Basle-Genoa.*	1 523	946	Daily. Winter.
	Mulhouse-Lyons-Ventimiglia.	978	608	Do.
	Basle-Chur.	207	129	Do.
Méditerranée Express	Calais-Paris-Ventimiglia.	1 430	889	Do.
Nord Express	Paris N.- *St. Petersburg.*	2 716	1 688	Twice weekly.
	Ostend-Liége.	225	140	Do.
	Berlin Sch.-*Moscow.*	1 952	1 213	Weekly.
Nord-Sud (Brenner) Express	*Berlin-Bozen-Cannes.*	1 624	1 009	Daily. Winter
	Bozen-Meran.	32	20	Do.
Orient Express.	Paris Est-Constantinople.	3 094	1 923	Daily & 4 t. a wee
	Budapest-Constantza.	1 112	691	Do. & 3 t. a wee
	(Paris-Constantza-Constantin.)	(3 123)	(1 941)	
Ostend-Vienna Express.	Ostend-Wels (East).	1 109	689	Daily. Summer
Ostend-Carlsbad Express.	*Wurzburg-Bad Kissingen.*	67	42	Daily.
	(Ostend-Vienna-Constantin.).	(3 043)	(1 891)	
	(Ostend) Nuremberg-Carlsbad.	203	126	Do.
	Eger-Marienbad.	31	19	Do.
Oberland Express.	Calais-*Paris N.-P. L. M.*-Interl.	915	569	Do.
Paris-Barcelone Express	Paris Q. O.-Barcelona.	943	586	Daily.
Paris-Carlsbad-Marienbad.	Paris Est-Carlsbad.	1 041	647	Daily. Summer
	Karlsruhe-Francfort.	142	88	Do.
Paris-Rome-Taormina	Paris-Taormina.	2 208	1 372	
	Messina-Palermo.	233	145	Summer.
	Pisa-Florence.	79	49	
Peninsular and Oriental Express	*Calais-Brindisi.*	2 194	1 363	Weekly.
Pyrénées-Côte d'Argent Express	Paris-Pierrefitte.	881	547	Daily. Summer
	Dax-Irun.	88	55	Do.
	La Négresse-Biarritz.	3	2	Do.
Riviera Express	Berlin-Ventimiglia.	1 864	1 158	Daily. Winter
	Amsterdam-Utrecht.	41	25	Do.
	The Hague-Francfort.	505	314	Do.
Rome-Florence-Cannes Express.	*Rome-Cannes.*	719	447	Daily. Winter
Savoie Express	*Paris P.L.M.-Geneva.*	605	376	Daily. Summe
	Bellegarde-Evian.	78	49	Do.
	Culoz-Chambéry.	36	22	Do.
St. Petersburg-Vienna-Cannes Exp.	*St. Petersburg*-Cannes.	3 094	1 923	Daily. Winte
	Podwolocyskavan-Vienna.	947	588	Do.
Simplon Express	Calais-Paris-Triest.	1 565	972	Daily.
Sud Express	Paris-Madrid.	1 455	904	Do.
	Medina del Campo-Lisbon.	644	400	Do.
	(Paris-Lisbon).	(1 809)	(1 124)	
Trans-Siberian.	*Moscow-Kharbine* (1).	7 504	4666	Weekly.
Trouville-Deauville Express	*Paris-Houlgate-Cabourg*	243	151	Do.
Vichy Express	*Paris-Vichy.*	365	227	Do.
Vienna-Naples-Palermo Express	*Vienna-Bologna* (etc.).	841	523	Daily, etc.
Vienna-Tyrol-Cannes Express	*Vienna-Bozen-Cannes.*	1 370	851	Twice weekly. W
	Budapest branch.	368	229	Do.
		56 322	35 003	

(1) The verst has been taken as = 0.663 mile.

Table 111.

DATE ON WHICH THE COMPANY'S GREAT EXPRESSES WERE STARTED.
Obsolete services are shown in italics.

Date.	NAME OF TRAIN.	Run of main rake.
5.6.1883	Orient Express	Paris Est-Constantinople.
8.12.1883	*Calais-Nice-Rome Express*	Calais-Rome.
5.11.1887	Sud Express	Paris Aust.-Madrid and Lisbon. (1.6.1895, through rake to Lisbon).
1889	Méditerranée Express.	See *Calais-Nice-Rome Express.*
3.6.1889	*Paris-Bordeaux*	*Paris-Bordeaux.*
1889	The *Club trains.*	*London-Dover and Calais-Paris N.*
1890	*P. and O. Express*	*Calais-Brindisi.*
1890	Bombay Express	Boulogne-Marseilles.
15.11.1890	Rome Express	Calais and Paris to Rome.
1890	*Switzerland Express*	*Calais-Lucerne.*
1st June 1894	Ostend-Vienna Express	Ostend-Vienna (1901, ext. to Near East).
1895	*Oberland Express (P. L. M.)*	*Paris P. L. M.-Interlaken.*
Mai 1896	Nord Express.	Paris N. and Ostend-St. Petersburg (1890: rake for Warsaw; 1921 : Riga rake; 1929 : Hamburg car).
1897	*Nord Sud (Brenner) Express.*	Berlin-Munich-Brenner-Naples (1901: Miland-Cannes rake).
1898	*Trans-Siberian*	Moscow-Irkutsk, then Vladivostok.
1898	*Luxor Express* (now « Star of Egypt ».	Cairo-Luxor (extended to Shellal in 1926/1927).
1900	*Riviera Express*	*Amsterdam & Berlin-Riviera (& Naples).*
1901	Engadine Express.	Calais-Paris N. and E.-Chur.
1901	Carlsbad Express	Paris (and Ostend)-Carlsbad.
1st June 1901	*Berlin-Budapest-Orient*	*Berlin-Budapest* (and Near East).
	Day trains	*Paris-Trouville.* *Paris-Vichy.* *Paris-Aix-les-Bains.* *Oberland-Geneva Lake.*
1903	Barcelone Express	Paris-Barcelona.
1903	*Amsterdam and Ostend-Switzerlnd Exp.*	*Amsterdam-Lucerne* and *Chur.*
1904	*Amsterdam-Mons Express*	*Amsterdam-Mons.*
1906	Simplon Express	Paris P.L.M.-Simplon-Milan (then Venice, Triest, finally the Near East).
1906	*Trans-Mandchurian Express*	Kharbin-Changchoun.
1907	*Lloyd Express*	Altona-Hamburg and Genoa.
1911	Pyrénées-Côte d'Argent Express	Paris-Hendaye, etc.

Table 111 (*continued*).

Date.	NAME OF TRAIN.	Run of main rake.
1913	*Vienna (Budapest)-Tyrol-Cannes* . . .	Vienna-Bozen-Cannes and Budapest portion.
1919	*Paris-Prague Express*	*Paris-Prague-Warsaw.*
1920	Simplon-Orient Express	Paris-Bucarest, then Constantinople and Athens.
1920	Calais-Méditerranée Express	Calais to the Riviera (+ Paris-Medit. in 1926).
1924	Suisse-Arlberg-Vienna	Paris Est-Vienna, then the East (1929, Lyons-Chur coach).
1924 and 1925	*All-sleeping-car trains*	Rome-Milan (1924). *Rome-Turin* (1925). *Rome-Venice* and *Triest* (1925). Rome, Naples and Sicily (1925).
1925	Milan-San Remo - Nice - Cannes Pullman Express	Milan-Cannes.
12.9.1926	The Golden Arrow (Pullman)	Paris N.-Calais Maritime.
1927 Summer.	*Vichy Express* (Pullman)	*Boulogne-Paris-Vichy.*
1st July 1927	Anatolie Express (All-sleeping-car train).	Haydarpasa-Ankara.
15.9.1927	*Gothard Pullman Express*	Basle-Milan (Coach from Paris).
15.6.1928	L'Etoile du Nord	Paris-N.-Brussels-Amsterdam.
1928	Calais-Brussels (Pullman).	Calais (or Boulogne)-Brussels N.
15.5.1929	*All-sleeping-car train.*	*Paris-Nice.*
Do.	The Blue Bird (Pullman)	Paris N.-Antwerp C.
Do.	*Carpati Pullman*	*Bucarest-Sinaïa* (Summer).
Do.	*Dunarea Pullman* . . . . (Danubiu Pullman Express.)	Bucarest-Galatz (Winter). Do.
Do.	Rapide Regele Carol I (Pullman). . .	Bucarest-Constantza (Carmen Sylva).
1929	Ostend-Cologne (Pullman).	Ostend-Cologne.
1929	*Rome-Naples Pullman*	*Rome-Naples.*
1929	*Paris-Côte Belge* (Pullman)	*Paris-Ostend* and *Knocke.*
1929	*Milano-Ancona Pullman.*	*Milan-Ancona.*
1929	*Milano-Montecatini-Reggio* (Pullman). .	*Milan-Reggio.*
1929/30 Winter.	Côte d'Azur Rapide (Pullman)	Paris P.L.M.-Mentone.
1930	Taurus Express.	Haydarpasa-Aleppo, then Tripoli.
5.6.1931	Golden Mountain Express	Montreux-Zweisimmen (metre gauge).
27.1.1934	Riviera Express.	Berlin-Milan-Cannes and Milan-Rome.

CHAPTER XVIII.

The Sleeping Car Company's important express trains.

XVIII-1. — **General matters.** — Since their creation in 1883, the number of these trains has rapidly increased, particularly at the end of the last century, and in the years immediately before the War, when they reached the high number of 25 great express trains in addition to four day trains. Today the number is 21, plus 10 Pullman trains.

It would be of small interest to consider these trains according to their geographical position only, but by grouping them into economic categories, we obtain an interesting light on international traffic conditions and the main currents of passenger traffic.

On the other hand, the fact that these services have frequently played the part of pioneers must not be lost sight of. The *Sleeping Car Co.* was the first to investigate their possibilities, as it is better placed than anyone else to realise these. Afterwards the railway companies set up similar services, less fast it is true, but more popular likewise, which in their turn are often followed by through mail and goods trains. In this way, the « Conventionnel » has doubled the *Sleeping Car Co.*'s « Orient Express » and the « Direct Orient » has followed the « Simplon-Orient Express ». It might well be worth studying not only the creation and the operation of each of these services, but also their sequence, and the influence they may have had on the economic conditions which determined their creation and reciprocally. But here we must content ourselves with calling attention thereto.

Another characteristic which must be stressed is the important part played by the great express trains in the carriage of postal matter, as the *Sleeping Car Co.* was, by its international character, in a better position to transport the mails than any railway company. If the *Sleeping Car Co.* was able to carry out, at lower cost than other companies, such important services, on the other hand the postal contracts which covered a considerable part of its expenses were a sort of indirect guarantee of its receipts and enabled it to introduce certain trains sooner than the normal traffic alone would have justified.

Besides, it is impossible to over-estimate the economic and political importance of some of the great international trains, which through the timings always becoming faster and the improved facilities offered to passengers, develop all kinds of exchanges between different countries. This was brought out in a striking way during the War and immediately afterwards, and one of the first preoccupations of both sides was the establishment or re-establishment of those trains particularly affecting them. Thus the Austro-Hungarian Empire was always opposed to the establishment of any Orient Express which did not run through Vienna on its way to the Balkans; Germany's first concern during the War was to set up a « Balkanzug » for its own profit, and the first of the great express trains to be restarted after the Armistice were those linking up Paris with Rome and Warsaw, although the latter had to be run round Germany.

We have grouped systematically the Company's trains in six categories as follows, under as many different headings, numbered XVIII-2 to XVIII-7.

A. — The first category includes those trains covering express services between Paris and London, on the one hand, and

Fig. 71.—The International Sleeping Car Co.'s great express trains

Table 112.

THE COMPANY'S GREAT EXPRESSES AT PRESENT.

Obsolete services are shown in italics.

NAME OF TRAIN.	RUN.	Distance Km.	Distance Miles.	
natolie Express.	Haydarpasa-Ankara.	578	359	
rlberg-Orient Express.	Calais-Chaumont-Bucarest.	2 882	1 791	3 times a week.
	Budapest-Athens.	1 562	971	
	Paris Est-Chaumont.	262	163	
alais-Méditerranée Express.	Calais-Paris N.-P. L. M.-S. Remo.	1 443	897	
alais-Paris-Prague-Carlsbad	Calais-Paris N.-E.-Carlsbad.	1 348	838	Summer.
ngadine Express	(Calais) Sargans-Chur.	26	16	
berland Express.	(Calais) Belfort-Interlaken.	202	126	
'ord Express	Paris-Berlin-Warsaw.	1 611	1 001	
	Ostend-Liége.	216	134	
	(Ostend-Warsaw).	(1 450)	(901)	
	(Calais-Warsaw).	(1 571)	(976)	
	Berlin Sch.-Riga.	1 144	711	
	(Hanover-Altona).	(187)	(116)	1 sleeping car. only.
	(Hanover-Copenhague).	(431)	(268)	
rient Express	Paris-Châlons-sur-Marne.	173	108	
	Calais-Châlons-s/Marne-Bucarest.	2 621	1 629	
stend-Vienna-Orient Express	Ostend-Wels (East).	1 109	689	
	Amsterdam-Cologne.	261	162	
	Budapest-Istambul.	1 426	886	
	(Ostend) Nuremberg-Carlsbad.	203	126	
	Eger-Marienbad.	31	19	
'. and O. Express	Calais-Paris P.L.M.-Marseilles Ar.	1 178	732	Weekly.
'yrénées-Côte d'Argent Express	Paris-Dax-Irun.	830	516	
	Dax-Tarbes.	144	89	
iviera Express	Berlin-Milan-Cannes.	1 667	1 036	Winter.
	Milan-Rome.	668	415	Do.
ome Express.	Calais-Paris N.-P.L.M.-Rome.	1 754	1 090	
	Pisa-Florence.	81	50	
ud Express	Paris-Madrid.	1 455	904	
	Campolide-Estoril.			
	Medina del Campo-Lisbon.	644	400	
implon-Orient Express	Calais-Paris N.-P.L.M.-Istambul.	3 364	2 090	
	Vinkovci-Bucarest.	864	537	
	Nisch-Athens.	955	593	
	Lyons-Milan.	492	306	
	Ostend-Milan.	1 146	712	
tar of Egypt	Cairo-Shellal.	892	554	Winter.
'aurus Express	Haydarpasa-Mouslimié-Aleppo.	1 418	881	
	Mouslimié-Tel Ziouane.			
ienna-Milan-Nice-Cannes	Vienna-Cannes.	1 297	806	
ll-sleeping-car train	Rome-Milan.	665	413	
	Rome-Syracuse.	866	538	
	Messina-Palermo.	233	145	
		37 711	23 433	

TABLE 112 (*continued*).

NAME OF TRAIN.	RUN.	Distance. Km.	Miles.	
Brussels-Calais Pullman	Brussels-Calais.	217	135	
Côte d'Azur Pullman	Paris-Mentone.	1 108	688	Winter.
Danubiu Pullman.	Bucarest-Galatz.	260	162	
Rapide Regele Carol I	Bucarest-Constantza.	227	141	
	Constantza-Carmen Sylva.	16	10	Summer.
Edelweiss	Amsterdam-Zurich.	899	559	
	Basle-Lucerne.	95	60	Summer.
Etoile du Nord	Paris-Brussels-Amsterdam.	545	339	
The Golden Arrow	Paris-N.-Calais Maritime.	299	186	
Milan-San Remo-Cannes	Milan-Cannes.	372	231	Winter.
The Blue Bird.	Paris-Brussels-Antwerp C.	361	224	
Ostend-Cologne Pullman	Ostend-Brussels-Cologne.	342	212	
	Total mileage of Pullman trains.	4 741	2 947	

the capitals of southern, central and eastern Europe on the other :

Nord Express;
Orient Express; Ostend-Orient Express; Arlberg-Orient Express;
Simplon-Orient Express.

B. — The second, fewer in number, includes a few important trains running from north to south, and connecting Amsterdam, Berlin and Vienna with the southern capitals :

Sud Express — Barcelona Express;
Nord-Sud Express — Riviera Express;
Paris-Rome Express — Berlin-Rome Express.

C. — The third category includes the important extensions into Asia and Africa :

The Trans-Siberian — Trans-Manchurian Express;
Anatolia Express — Taurus Express;
Star of Egypt Express.

D. — The fourth category is that of the boat trains :

Golden Arrow — Calais-Brussels Pullman — Ostend-Cologne Pullman;
P. & O. trains: Peninsular and Oriental Express — Bombay (Marseilles) Express;
Norddeutscher Lloyd trains : Egyptian Express — Lloyd-Riviera Express.

E. — The fifth category, almost entirely seasonal, includes trains serving the great holiday and tourist centres :

Pyrénées-Côte d'Argent Express — Savoie Express;
The Riviera « de luxe » trains;
Calais-Switzerland Express — Oberland Express — Engadine Express — Ostend (Amsterdam)-Switzerland Express;
Vichy Express — Paris-Prague and Carlsbad Express — Ostend-Carlsbad — Berlin-Carlsbad and Marienbad.
Côte Belge Express — Deauville Express.

F. — Finally in the sixth batch we have

TABLE 113.

A FEW COMPARATIVE EXPRESS TRAIN TIMINGS
in 1914 and now (1933/1934).

NAME OF TRAIN.	Principal runs.	Distance Km.	Distance Miles.	Time spent.	Speed Km.	Speed Miles.	Time spent.	Speed Km.	Speed Miles.
				In 1914.			At present.		
Latitudinal trains.									
l Express	Paris-St. Petersburg . .	2 716	1 688	42.37	66	41	...	...	...
	Do. -Moscow	3 024	1 879	52.36	58	36	...	...	...
	Do. -Berlin	1 077	669	16.44	64	40	13.11	82	51
	Do. -Warsaw (Torun) .	1 712	1 064	27.29	62	39	...	...	...
	Do. do (Kutno) .	1 611	1 001	...	...	...	22.35	73	45
	Do. -Riga	2 194	1 363	...	..	...	36.55	59	37
ns-Siberian	Moskow-Kharbine . . .	7 904	4 911	8d.2m.	41	25	...	...	...
nt Express	Paris-Vienna.	1 384	860	28.16	49	30	20.10	69	43
	Do. -Budapest	1 693	1 052	36.30	46	29	25.48	65	40
	Do. -Bucarest . . .	2 579	1 603	64.20	40	25	42.30	61	38
nd-Vienna Express . . .	Ostend-Vienna	1 324	823	25.19	52	32	20.03	66	41
erg-Orient Express . . .	Paris-Vienna.	1 490	926	...	...	...	22.45	65	40
olon-Orient Express . . .	Paris-Bucarest	2 690	1 672	70.50	38 (1)	24	50.07	54	34
	Do. -Istambul	3 050	1 899	94.30	32	20	58.18	52	32
	Do. -Athens.	3 497	2 173	109.11	32	20	62.15	56	35
tolie Express	Haydarpasa-Ankara . .	576	358	...	...	...	15.50	36	23
rus Express	Do. -Tripoli . .	1 728	1074	...	...	...	47.05	36	23
Longitudinal trains.									
Express	Paris-Madrid.	1 455	904	25.56	56	35	22.00	66	41
	Do. -Lisbon.	1 891	1 175	34.36	55	34	31.17	61	38
e Express	Paris-Rome	1 446	899	31.30	46	29	21.45	66	41
ard Pullman	*Paris-Milan . . . . .*	*932*	*579*	...	...	...	*12.45*	*72*	*45*
Boat trains.									
nd O. Express	Calais-Marseilles Arenc .	1 178	732	16.35	72	45	18.40	63	39
Do.	Do. -Brindisi	2 394	1 488	39.52	60	37	...	...	...
Riviera trains.									
is-Méditerranée	Calais-Ventimiglia. . .	1 435	892	21.13	68	42	22.13	65	40
era Express	Berlin-Rome	1 966	1 222	(2)29,55	66	41	30.25	64	40
	Do. -Cannes (3) . . .	1 667	1 036	35.36	47	29	26.00(4)	63	39
d-Riviera Express. . . .	Do. do. . . .	1 788	1 111	29.06	62	39	...	...	...
Petersburg-Vienna-Cannes .	St. Petersburg-Cannes .	3 094	1 923	65.31	47	29	...	...	...
	Vienna-Cannes	1 297	806	27.48	47	29	23.20	56	35
Other holiday trains.									
énées-Côte d'Argent . . .	Paris-Irun.	830	516	11.25	72	45	12.04	70	43
adine Express	Paris E.-Chur	733	455	13.38	54	34	10.26	70	43
rland Express	Paris P.L.M.-Interlaken.	607	377	10.40	57	35	...	...	...
Do.	Paris Est -Interlaken.	643	400	...	...	...	13.05	50	31
of Egypt.	Cairo-Luxor	674	419	13.30	50	31	12.30	54	33
	Do. -Assuan	880	547	...	...	...	16.00	55	34
Sleeping-car trains.									
	Rome-Sarzana-Milan . .	665	413	...	...	...	10.20	64	40
	Do. -Syracuse	866	538	...	...	...	17.55	48	30

When first run, in 1919/1920. — (2) « Berlin-Rome-Palermo Express ». — (3) « N. S. (Brenner) Express ».
The distance is now 1 630 km. (1 013 miles).

Fig. 72. — The « Nord Express ».
Obsolete runs are shown by a dotted line. — Scale 1 : 1 800 000.

included the important day expresses not mentioned in the above categories :

Amsterdam-Mons Express;
Paris-Bordeaux Express;
Various Pullman trains: Edelweiss, Gothard Express, Andalousie Express, etc.

However, in addition to this general examination, which relates above all to the important international express trains, the trains and services special to each country must also be examined, as well as the route followed in each country by trains which run through several countries, as the local conditions influence such runs. Finally, in order not to make our report too heavy, we will do this while considering the services of each country as a whole, which is all the more logical as in many of them, such as England, Germany, Switzerland, and the central States there are sleeping-car or dining-car services run by other companies, and it would be illogical to study these separately.

Finally, some countries, such as the Iberic Peninsula and Russia, have always had their own rolling stock, because their gauge differs from the standard gauge used in other countries. Mention must also be made of the metre-gauge stock of recent use in Switzerland and Sardinia, and the 3 ft. 6 in. gauge rolling stock used in the Belgian Congo and the Portuguese Congo.

XVIII-2. — **The great latitudinal expresses.** — There are three important latitudinal inter-capital express trains : the « Nord Express » in the North, the « Orient Express » in the Centre, and the « Simplon-Orient Express » in the South. There are also two important longitudi-

nal trains: the « Sud Express » in the West and the trains from Berlin to Rome (Nord-Sud Express, etc.) in the Centre.

a) The Nord Express (fig. 72) is a very old train which originally, under the name of « Nord-Sud Express », connected St. Petersburg to Berlin, Paris, Madrid and Lisbon, as well as to Brussels and London by a supplementary portion. It was and still is worked in two portions, the part with which we are dealing, the « Nord Express » from Paris, Calais and Ostend, running as a single train as far as Liége and being divided up into two portions in Berlin, one of them going to St. Petersburg and the other to Moscow, in connection with the « Trans-Siberian ».

Interrupted by the War, it was found indispensable for political and military reasons to re-establish this train immediately afterwards, and for some time Paris was linked up with Warsaw by running round Germany in the South (1). Afterwards the service was run in its present form from Paris and Ostend to Liége and Berlin Schl. where it divides up into two portions serving the Baltic States, one of which ends up at Warsaw and the other at Riga.

Between Cologne and Hanover, however, the route via the Wuppertal, Hagen-Hamm, has been substituted for that via Dusseldorf-Duisburg-Dortmund, and the journey shortened by 33 km. (20.5 miles).

One coach from Calais runs in this train as from Brussels (1); another is taken off the train at Cologne, since 1929, for Hamburg and Altona, and for some time went as far as Copenhagen.

Because of the economic depression the « Nord Express » only becomes a special train after Liége; up to there, in fact, the coaches from Ostend and Paris are conveyed by the ordinary fast express trains run by the railway companies.

b) **The Eastern expresses.** — The capitals of Western Europe are in communication with the Balkan capitals by a series of trains — the « Arlberg-Orient », the « Orient Express » and the « Ostend-Vienna Express » — which serve Central Europe by following the long valley of the Danube, and by the « Simplon-Orient Express » further south, which gives the same facilities to Switzerland, Italy and Croatia, and whose route, which is 60 km. (37.3 miles) shorter, follows the valleys of the Po and Save as far as Belgrad, where it links up with the preceding train.

The timings of these trains are knit together so closely that it is difficult and quite useless to separate them here, the more so as the routes followed by the first two, which separate in Paris, rejoin at Salzburg, separate once more at Vienna to join up again at Budapest, parting again at Szolnok to meet again on the common route from Teius to Bucarest.

The Orient Express (fig. 73) has played a preponderating part in the development of the European international services. The oldest of all the great expresses, it was the first to benefit by the improvements of every kind introduced by the Company. Furthermore, it had a political influence greater than that of any other train, with the exception perhaps of the « Simplon-Orient Express ».

It ran for the first time between Paris Est and Vienna on the 5th June, 1883. It was even then composed of bogie sleeping cars, vans belonging to the Company and

(1) A diversion of the « Orient Express ».

(1) Before the War, this was a separate portion which met the Paris portion at Jeumont.

Fig. 73. — The « Orient Express » and the « Arlberg-Orient Express » and subsidiary branches (including the « Ostend-Vienna-Orient Express »).

Subsidiary branches are shown by a thin line, the « Orient Express » by a heavy line, the « Arlberg-Orient Express » by two parallel lines. Obsolete services are shown by a dotted line.

a six-wheeled dining-car which was soon replaced likewise by bogie rolling stock.

Prior to the inter-connection of the Serbian and Bulgarian Railways, it ran to Bucarest and Varna, from which place the last stage of the journey was by boat. This service has been maintained, but the maritime stage has been transferred to Constantza.

Extended to Constantinople, this train connected Paris, Vienna, and Budapest with all the Balkan capitals, thanks to its subdivision into two portions, which both eventually reached Constantinople and at about the same time : by land, via Belgrad and Sofia, the train arrived at 10.17 a.m.; the composite journey via Bucarest and the sea route arrived at 11.0 a.m. the passengers having embarked at Constantza the evening before at 11.0 p.m.

It was only in 1901 that a similar train was introduced from Berlin to Budapest, the coaches of which linked up with those from Paris and a coach from Ostend previously attached at Wels. Under the name of « Balkanzug » this train became of great importance during the War and prepared the way for the extension to the other side of the Bosphorus, since carried out by the *Sleeping Car Co.*

As soon as the Armistice was signed, for political reasons, the « Orient Express » was re-established as a military train running three times a week between Paris and Warsaw, passing to the south of Germany. It then ran from Paris to Basle and Linz (following the present route of the « Arlberg-Orient Express »), Vienna (West [1] and North stations) and Oderberg, while at Linz a rake was detached for Prague [2]. In this way an embryo « Nord Express » was re-established, while access to the Near East was gained by the new extension of the « Simplon-Orient ».

In view of the close political relations between France and Poland, the journey from Paris to Warsaw was soon shortened by suppressing the detour through Vienna and continuing the old rake for Prague directly to Warsaw, until the re-establishment of the « Nord Express », which it would have duplicated, made it possible to suppress it.

The distance from Paris to Warsaw by these various routes is as follows :

Nord Express, before the War [3], 1 718 km. (1 067 milles);

Nord Express, after the War [4], 1 611 km. (1 001 miles);

Via Vienna and Prerov, 2 090 km. (1 299 miles);

Via Prague and Prerov, 2 026 km. (1 259 miles).

As for the « Orient Express » it went back to its old route, via Strasbourg, Munich and Vienna as far as Bucarest (where it ended, instead of continuing to Constantza) and Istambul. As in the past, it picked up at Wels the coaches from Ostend and Amsterdam from the « Ostend-Vienna Express ». To be exact, the common trunk was limited to the Wels-Budapest section, with a western fork to Paris (and Boulogne) and Ostend (and Amsterdam), and an eastern fork to Bucarest and Istambul.

The through rake from Calais (or Boulogne) via Amiens then branched off to Gagny, at the 15th km. post from Paris; during the season it avoided Paris by following the cross country line from Laon to Chaumont.

Finally, the old « Paris-Prague » (and Carlsbad) continues to exist in the form of a rake detached at Stuttgart. At Nuremberg, where it crosses the « Ostend-Vienna » the Ostend-Carlsbad portion is added to it and sometimes also this latter portion joins up with a rake from Berlin.

The events in the Ruhr also had their repercussion on the « Orient Express » which had to be sent from Paris to Basle, following the route now taken by the « Arlberg-Orient » in order to join up with its own route again at Wels. But since this thorny question has been settled, the « Orient Express » once more runs over the direct route across the south-west of Germany.

We gave elsewhere in this note a few details about the route followed by this train in order to get from the *Nord* to the *Est* system. In dealing with the Austrian and Hungarian services, we will also deal with the run between the Western and Eastern stations, both in the case of Vienna and Budapest. The « Orient Express », before the War, took 1 h. 20 m. between its arrival at Paris-Nord and its departure from Paris-Est, and 3 h. 15 m. from its arrival at, and its departure from, Vienna. At that time it only entered one of the terminal stations of Budapest.

(1) The call at this station was abolished in 1920.
(2) Via Budweis.
(3) Via Cologne-Duisburg-Berlin and Torun.
(4) Via Cologne-Wuppertal-Berlin and Kutno.

Fig. 74. — The « Simplon-Orient Express » with its subsidiary branches.

Between these two capitals, it follows the 292-km. (181 miles) route north of the Danube, while the « Arlberg-Orient Express » and all the other services of the Company run over the 268-km. (167 miles) line which connects the two capitals on the southern bank of the Danube (1).

(1) Before the War, the distances from Vienna to Budapest-East were respectively 278 and 270 km. (173 and 168 miles). The distances between the two Viennese terminal stations (East and West stations) was 17 km. (11 miles).

The Ostend-Vienna Express was introduced in 1895. It was very soon extended to Budapest, and since 1901 has included through coaches for the Near East and under the name of « Ostend-Vienna-Orient Express » runs to timings closely linked with those of the « Orient » and « Simplon-Orient Express » (figs. 73 and 74).

After the War it was diverted to Milan, where it joined up with the new « Simplon-Orient Express », but as soon as possible after the War it was restored to its old route. Today it includes a rake from Ostend to Wels-Vienna-Budapest-Istam-

bul, and another from Amsterdam. This latter is attached to it at Cologne and leaves it at Budapest whence it runs to Bucarest. The « Ostend-Vienna » and the « Orient Express » join up at Wels (sometimes at Linz).

Three other services have used this train. During the Summer there are coaches labelled « Ostend-Carlsbad (or Karoly-Vary) Express » which are detached at Wurzburg and split up at Eger for Carlsbad or Marienbad. During the whole of the year, there was another important rake, the « Ostend-Triest Express » which serves that important Adriatic port, and runs in connection with the *Lloyd Triestino's* mail boats. Since the « Simplon Express » was extended from Vienna to Triest there was no longer any need for it and it has been suppressed.

Finally a through coach for Bad Kissingen was detached at Wurzburg.

The Arlberg-Orient Express (fig. 73) started in 1924, between Paris and Vienna, as a simple sleeping-car train. It soon had a through coach for Bucarest added to it, and its timing was brought into line with those of the other eastern trains. In 1928, it was extended to Boulogne either via Paris, or, when the traffic justified this, avoiding Paris by means of the cross-country line via Laon.

Two of the through sleeping-cars (from Lyons to Zurich and Chur and from Paris to Bad Gastein) have been suppressed. On the other hand, two important rakes have been added which were separate trains at one time : the « Oberland » and the « Engadine Express ». They pick up this train at Chaumont and are detached from it at Belfort and at Sargans.

The Simplon-Orient Express (fig. 74) is one of the most remarkable of the European trains. Resulting from the War, as it was started solely with the object of being a political link over a route where economic currents of traffic were yet to be created, it has started a unique series of international connections between all the Western capitals and those of Central and Eastern Europe. Since then, extending beyond the continental limits, it has penetrated into Asia where it fulfils the same role for the States formed out of the former Turkish Empire, and with one extension after another it has reached Egypt and even Persia, a promise for direct connection with India and beyond.

The importance of this train is thus far greater than that of the railways over which it runs. Consequently its working must be analysed in some detail.

After the Armistice it was necessary, in the first place, to have rapid connections between Paris and London, on the one hand, and the capitals of Central Europe and the Near-East on the other, and it was an Intergovernmental Conference which decided that this train should be created, and the *Sleeping Car Co.* was entrusted with the task. The Austro-Hungarian Empire was always opposed to the creation of a second important route between Western and Eastern Europe through its southern provinces; consequently it was only after it broke up that the idea was carried into effect, although it had been suggested as long ago as at the International Timetable Conference at Bremen, in June 1906, the year the Simplon tunnel was opened.

The reasons which the former Empire might have had in opposing the establishment of an important South-Slav train could not exist for the new Serbo-Croat State; consequently during the negociations which led to the signing of the

Peace Treaty, delegates representing the French, Belgian, Jugoslav, Swiss and Dutch railways, as well as the *Sleeping Car Co.*, formed a special Commission which drew up in less than a month the conditions under which the new train should be run. In view of the political contingencies, they had the good idea of establishing it under conventional autonomous control intrusted to the *Paris, Lyons & Mediterranean.*

Since then, the extent of the relations it covers has become so great that this special Simplon-Orient Express Commission at the present time includes representatives of the following Administrations :

Paris, Lyons & Mediterranean, Paris-Orleans, Nord and *Alsace-Lorraine;*

The *Belgian, Dutch, Swiss, Italian, Jugoslav, Bulgarian* and *Rumanian Administrations;*

The *Compagnie des Chemins de fer Orientaux*, the *Compagnie Franco-Hellénique.*

and also, since the extensions across the Bosphorus :

The *Turkisch State*, the *Bozanti-Aleppo-Nissibin* Ry. and its extensions, the *Damas-Hamah* Ry. and the *Iraq Railways.*

The Simplon-Orient Express which uses the *P.L.M.* system and runs through the Simplon tunnel, to Milan, Venice, Triest and Agram, while the « Orient Express » remains attached to the *Est* Railway, has had many additions made to it since it first ran on the 19th April, 1919, as well as extensions outside Europe, which we will deal with in Chapter XVIII-4.

In its present form, it differs from all the other important expresses of the Company in that it is not properly speaking a train coming from Paris (and London) towards a series of destinations which it reaches by dividing up into a corresponding number of diverging portions, but through force of circumstances has become a train connecting all the great Western capitals — Paris, London, Brussels, Amsterdam, Berlin and Prague — to Vienna, Budapest and all the capitals of the Near-East : Athens, Belgrad, Sofia, Bucarest, Istambul, and even further east, Ankara, Beyrouth, Cairo and Teheran.

At the beginning attention was focused on three portions directed towards Milan:

Paris, Simplon, Milan, 17 h. 55 m. for 841 km. (523 miles);

(Bordeaux) Lyons, Mount-Cenis, Milan, 17 h. 9 m. for 492 km. (306 miles);

Ostend, Saint-Gothard, Milan, 22 h. 45 m. for 1 150 km. (715 miles).

But the portion from Bordeaux to Lyons, known as the «45th Parallel Line» never paid its expenses and was given up in 1922. The portion from Ostend was abandoned in favour of the old route of the « Ostend-Vienna Express ». The distance from Ostend to Vienna-Belgrad was 2 300 km. (1 429 miles) by the « Simplon-Orient », and 1 982 km. (1 232 miles) by the « Ostend-Vienna » (1).

On the other hand, the Paris *P.L.M.* portion was extended, without passing through Paris Nord, as far as Calais Harbour.

It has been found possible to combine the timings of the « Simplon-Orient » with those of the « Ostend-Vienna-Orient Express ». In addition, various sleeping-car services are included in the « Simplon-Orient » over part of its journey, so that at the present time it includes the following services :

Principal constituent portions :

Calais-Paris-Vinkovci-Belgrad-Istambul;
Paris-Vinkovci-Belgrad-Piræus;
Paris-Vinkovci-Bucarest.

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(1) Vinkovci, where the two lines meet, is 165 km. (102 miles) from Belgrad.

Connections running in the « Simplon-Orient Express » over part of its route :

Istambul - Budapest - Breslau - Berlin Schles. Bhf;

Istambul - Budapest-Vienna - Ostend (in the « Ostend-Vienna ») ;

Istambul-Budapest-Vienna-Paris Est (in the « Arlberg-Orient ») ;

Athens-Budapest-Prague-Berlin Schles. Bhf;

Athens-Budapest-Vienna ;

Athens-Budapest-Vienna-Paris Est (in the « Arlberg-Orient »).

The Greek portion was started in July 1920 and the extension from Paris to Calais in 1921.

The train leaves Berlin daily, either for Athens or for Istambul. The departure from Istambul also takes place daily for Ostend, Berlin via Breslau, or for Paris via the Arlberg. The train leaves Athens daily for one of the three destinations given.

The « Simplon-Orient Express », which was at first a weekly train, soon ran four times a week and then daily. The time taken for the journey has frequently been reduced, the effect this had on the service as a whole being of greater importance than the local desires for convenient train times, so that instead of 90 h. 30 m. from Paris to Constantinople in 1920, the present-day time is only 58 h. 18 m. Below we give the successive stages :

1920 : 96 h. 30 m.	*1928* : 66 h. 50 m.
1922 : 88 h. 50 m.	*1929* : 66 h. 10 m.
1924 : 83 h. 25 m.	*1934* : 58 h. 18 m.
1926 : 70 h. 25 m.	

The times taken for the journey from Paris to Constantinople, by the « Simplon-Orient Express », by the former route used by the « Orient Express » and even by the « Arlberg-Orient Express », are very much the same, the departures from Paris being timed respectively at 7.40 p.m. (*P.L.M.*) and at 7.55 (for the two *Est* trains), the « Simplon-Orient » and the « Orient Express » joining up again at Belgrad.

However, starting from London and travelling either via Calais or Ostend, there is a saving of three hours in favour of the *Est* system, on which the English rake joins up with the Paris portion of the train at Châlons-sur-Marne, which saves a considerable detour.

The ground having been broken, the « Simplon-Orient Express » was duplicated after 1921 by a train known as the « Direct-Orient », made up of rolling stock belonging to the various railway companies and also run under special agreements. In Italy the speed of the two trains is the same, but that of the « Direct-Orient » is less over the 1 200 km. of its journey through Jugoslavia and beyond, so that in spite of the improvements made after the Brussels Conference, the total time taken for the journey is 84 hours.

XVIII-3. — **The great longitudinal expresses.** — Two great express trains link up Paris with the Spanish and Portuguese capitals, and three serve Italy :

The Sud Express started on the 5th November 1887 from Paris to Madrid and Lisbon, and ran in connection with the liners for South America. At the beginning, however, it only ran from Paris to the Spanish frontier, and from Madrid to Lisbon, as no agreement could be come to with the *Norte* Ry. about the intermediate route. However, even after an agreement had been made for the journey from one end to the other, it was inconvenient to have to send passengers for Lisbon via Madrid; so after the 1st June, 1895, when the traffic justified such a step, the « Sud Express » was made up of two rakes which split up at Medina del Campo, one portion going to Madrid, and the other straight on to Lisbon.

The Barcelone Express, which dates from 1903, is no longer made up entirely of *Sleeping Car Co.* rolling stock. At the present time it is a train run by the *Paris-Orleans* and *Midi* Companies, which includes vehicles of the *Sleeping Car Co.* for separate destinations.

Both these expresses only run as far as the frontier from which point the journey is continued by broad-gauge (1. 67 m. = 5 ft. 6 in.) rolling stock.

Services to Italy. — Following its plan to link up the European capitals, the Company set up services giving direct communication between Rome and the capitals of Central and Eastern Europe (fig. 75): Paris, and London, Berlin, and formerly St. Petersburg.

Fig. 75. — The Company's great Rome express trains.

The first of these trains was the « Calais-Nice-Rome Express » which is nearly as old as the « Orient Express », as it ran for the first time on the 8th December, 1883. Since then it has been diverted via the Mount-Cenis tunnel, and in this way the Paris-Rome services have always been worked by the *P.L.M.* Railway. It is true that there is some question of transferring the « Rome Express » to the *Est* System. It would then run via the Saint-Gothard and use the new direct line from Bologna to Florence, but nothing has yet been settled.

In 1886, the London connection was covered by a special train from London to Dover with a connecting boat, in exactly the same way as has since been done for the « Golden Arrow ». After the 15th November, 1890, the train which had become the « Calais-Rome Express » was sent via the Mount-Cenis tunnel.

The « Rome Express » was one of the first trains to be re-established after War was declared. At the Armistice, its aim was to assure the service to Greece and Turkey until the « Orient Express » was restarted, and it was first of all extended to Brindisi, and then to Tarenta, where passengers embarked for Corinth and Constantinople. It now only runs to Rome (or Naples) except during a few months each year, when it is extended to Sicily.

As Rome had to be linked up, not only with Paris and London, but also with other capitals, other trains were added, such as the « Nord-Sud (Brenner) Express » in 1897, and the « Riviera Express » in 1900, some of which join up for part of their journey.

When the « Rome Express » is extended to Naples and Reggio it is sent to Sicily by the ferryboat across the straits between Reggio di Calabria and Messina, where all these trains branch off to Pa-

lermo or to Taormina-Giardino and Syracuse.

In the other direction, the train divides up at Pisa, whence one portion goes to Paris and the other to Bologna where it splits up again into two portions, one of which continues to Berlin and the other to Vienna and formerly to St. Petersburg.

In 1919 the « Paris-Rome », re-established once more, was extended to Bari and Tarenta. The journey took 14 hours between Rome and Tarenta where passengers embarked for Corinth and Constantinople. However, at the end of 1920, this extension, which was no longer required after the « Simplon-Orient Express » had been re-established, was abandoned, and replaced by an extension from Rome to Brindisi via Caserte and Bari (2 048th km. = 1 273rd mile) which in now obsolete in its turn [1].

A through rake from Boulogne joined the main train at Paris *P.L.M.* after having already run into Paris Nord, the total time spent in Paris being 1 h. 5 m.

The Nord-Sud Brenner Express, started in 1897, ran between Berlin, Rome and Naples. Since then its route has been altered in order to send it via Munich and Milan, to Cannes.

The other North-South trains are holiday or health resort trains (« Riviera Express »), or boat trains (« Lloyd Express », « Egyptian Express » or P. & O. Express ») with which we shall deal later on.

Finally a series of sleeping car trains was established, the first of which, from Paris to Nice and Paris to Vienna, via the Arlberg, were soon followed by a whole series of trains linking up Rome with the important provincial centres : Milan (by two different routes), Venice and Triest, Genoa and Turin, Reggio di Calabria and Sicily.

Only two of these trains survive at the present time : they are those from Rome to Milan via Sarzana, and from Rome to Naples and Sicily, to which must be added that from Warsaw to Poznan, which has been suppressed since the « Nord Express » has been re-established.

XVIII-4. — **The extension of the great through services into Asia and Africa.** — When studying the map, it is always pleasant to dream of setting up means of communication or penetration lines. The *International Sleeping Car Co.* has put its dreams into practice, and its great expresses have followed step by step the laying of new railways. By facilitating access to new countries, they have increased the rate of development of the latter. Two of the best examples are those of Asiatic Russia and Asia Minor.

Asiatic Russia (fig. 76). — When the Trans-Siberian Express only ran from Moscow to Irkutsk, the Company signed a contract with the Russian Government on the 1/13th April 1898, which authorised it to run a Trans-Siberian « de luxe » train and transferred to it the working of the dining and sleeping-car services of the « Siberian Courier » whose sleeping berths were not fitted with toilets. The original terminus at Irkutsk was moved forward as the work of laying the line proceeded, and by its connecting trains, the « Trans-Siberian » shortened considerably the journey towards Vladivostok, China and Japan.

Since the Soviet Republic was set up, the *International Sleeping Car Company*

(1) The distance between Rome and Tarenta is 618 km. (384 miles) which is 4 km. (2.5 miles) less than that between Rome and Brindisi.

has seen the profits of its operating contracts, including the Trans-Siberian as well as the others, taken from it.

For some time it maintained, under the name of TRANS-MANCHURIAN EXPRESS, a special train from the Sibero-Manchurian frontier (at Manchuria) as far as Vladivostok (1 751 km. = 1 088 miles) (1) with a portion from Kharbin to Chang Choun towards Peipin. When the train could only be run within the Manchurian frontiers, from Manchuria to Pogranitchnaia (1 481 km. = 929 miles) (2), and the maritime part of the journey had to be suppressed, the Company ceased to run this special train a few years ago only, and now content themselves with sleeping-car and dining-car services on the trains of the Companies concerned.

Asia Minor and mandated territories (fig. 71). — During the War, Germany drew up a programme for extending the great express trains to the East beyond the Bosphorus and constructed the *Taurus Railway*, which is one of the most striking examples of engineering skill. The idea was taken up after the War and adapted to the conditions resulting therefrom, in order to obtain a working connection between the European railway systems, those of Asia Minor, and of countries even further off.

The decision was made at the Baden-Baden Conference, in 1925, at which the Administrations concerned laid down the principles for regulations concerning two new trains, the rolling stock and working of which was to be covered by the *Sleeping Car Co.*, which also had to maintain by steamers the connection between Istambul and Haydarpasa, on the Asiatic coast of the Bosphorus.

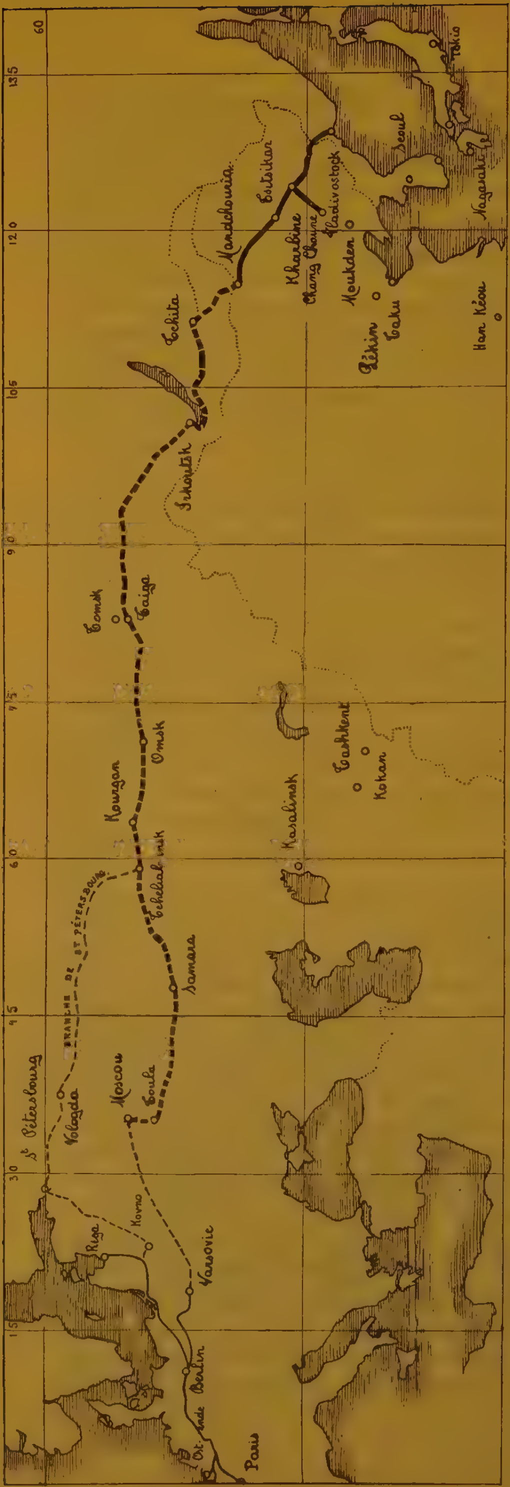

Fig. 76. — The Trans-Siberian and the Trans-Mandchurian.

(1) 1 604 versts.
(2) 1 388 versts.

The ANATOLIA EXPRESS takes 16 hours from Haydarpasa to Ankara via Eskisehir. Lately it has included a through sleeping-car service as far as Sivas.

The TAURUS EXPRESS makes direct connection with the « Simplon-Orient » of which it is an extension. It makes a double connection with Syria and with Iracq, the two portions of the train dividing up at Aleppo, 1 728 km. (1 074 miles) from Haydarpasa.

The first portion serves the countries under French mandate, and this previously went to Rayak where the standard gauge track came to an end. Thence it was possible to travel either to Damas by a 1.05-m. (3 ft. 5 3/8 in.) gauge line, or to Beyrouth by road motor car. This portion has since been diverted to the port of Tripoli which is only a two-hour motor run from Beyrouth, and six hours from Haifa where the railway is picked up again for Cairo. In spite of this gap the line gives direct and rapid communication between London (and Paris) Beyrouth and Cairo, the time of the journey being comparable to that by sea. In fact, now it only takes 6 days, 1 h. 20 m. to go from Cairo to London (or 5 days, 16 h. 40 m. to Paris), and 5 days, 1 h. 20 m. from Beyrouth to London (or 4 days 21 h. 10 m. to Paris) (1). The average overall speed is therefore 42 km. (26 miles) an hour between Cairo and London.

The other portion of the « Taurus Express » covers the connection with Iraq as well as with Persia, but the frontiers given to the mandated countries have complicated the working. After Adana, the line actually passes by Aleppo, in Syria, re-enters Turkey in order to serve Nissibin, and ends at Tel Ziouane, in Syria once more. The gap between the *Iraq Railways* system is covered between Tel Ziouane, Mossul and Kirkuk by road motor services belonging to the Iraq Railways, as is the third gap between Khanijin, on the Iraq-Persian frontier, and Teheran, in which case the motor service is controlled by the *Sleeping Car Co.*

By this composite route, the journey from Haydarpasa to Bagdad only takes 3 days 21 hours, and 4 days 20 hours as far as Bassorah, whence the boats of the *British India Steam Navigation Co.*'s liners go to Bombay in a week.

In the direction of Persia, it takes 5 days 7 hours from Haydarpasa to Teheran (7 days, 18 hours from Paris, and 8 days 3 h. 30 m. from London), in spite of two nights, at Mossul and Hamadan on the way, in order to avoid motor journeys by night.

In both cases, these services are valuable means of bridging a gap in the railway systems and not permanent substitutes therefor. Their function may be best compared, in new countries of this nature, to that of ferry boats which carry rolling stock across the large rivers until the time when the traffic becomes sufficiently important to make the construction of a permanent bridge worth while.

It is obvious that, in spite of the considerable development of motor transport on the wonderful Syrian roads, the missing section of railway between Tripoli

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(1) The distances between London and the towns mentioned are as follow :

Calais	166	103
Istambul	3 506	2 178.5
Haydarpasa	3 508	2 179.7
Aleppo	4 926	3 060.7
Tripoli	5 236	3 253.5
Beyrouth	5 428	3 372.5
Cairo	6 191	3 847

And on the other branch :

Mossul	5 581	3 467.7
Kirkuk	5 136	3 591.5
Teheran	6 762	4 202
Bagdad N.	6 102	3 791.5

and Beyrouth will be constructed as soon as circumstances permit, as well as the connection by railway of Tel Ziouane with Kirkuk.

The original timing of the « Taurus Express » has been successively improved in order to speed up the journey, according to the decision of the Brussels Conference in 1932, and again after the 15th May, 1933.

Its operation, which was very profitable at first, has felt the effects of the crisis very severely. In order to mitigate this, reduced rates have been put into force, and, an interesting innovation, return tickets valid for two years are issued at a reduction of 25 %.

Thanks to the energy of the Administration managing the « Simplon-Orient Express », the latter has shown its vitality by constant improvements in its timing, and by continued extensions both in Europe and in Asia. The complexity of the problems arising from this can be estimated when one considers that at the present time there are 16 Administrations concerned in Europe and already 5 in Asia, the progress made being the fruit of the labours of some forty plenary conferences.

Egypt. — The *Sleeping-Car Co.*, in 1898, signed about the same time contracts with Russia and Egypt, and so at an interval of a few months penetrated into Asia and Africa.

Its first African « de luxe » train, which is now called « The Star of Egypt » was started between Cairo and Luxor where the standard gauge line then ended. Since the 3 ft. 6 in. gauge line which continued on into Upper Egypt was widened to 4 f. 8 1/2 in., this train has been extended as far as Assuan and Shellal, from which latter place boats leave for the Sudan. This train is made up of as many as eight sleeping cars.

XVIII-5. — The Company's boat trains (fig. 77) can be grouped in three classes : those which deal with traffic from London to Central, Southern or Eastern Europe; those which link up Paris with the French embarkation ports; and finally the transcontinental trains enabling passengers to embark at one or other of the ports of call of the transatlantic or transmediterranean liners.

1. The Anglo-Continental traffic is covered in Europe by the following trains :

a) At Calais or at Boulogne, two short-distance Pullman trains, with their connecting trains between London and Dover, link up Calais with Paris and with Brussels. The first of these trains, the Golden Arrow, was started in 1926, but as early as 1889, during the Paris World Exhibition, the *Sleeping Car Co.* had run « Club trains » over the same route on both sides of the Channel. The English train consisted of 4 day coaches (three saloons, one composite smoking room-van and one four-wheeled van); the French train had in addition a dining car, with a kitchen in the van. These short-lived trains had seats for 66 passengers; the « Golden Arrow » with 4 couplings can seat 290.

The Calais - Brussels Pullman includes a sleeping car from the « Nord Express ». Formerly this went straight to Liége via Jeumont, which made necessary a special train from Calais and Jeumont, but kept the coach for a longer time on the *Nord* system. The present route, which joins the former at Liége, is shorter.

b) The « Orient Express » and the « Arlberg Oberland-Engadine Express » pass from the *Nord* system to the *Est* without entering Paris, by making use of the cross-country line through Laon.

Fig. 77. — The *Sleeping Car Company*'s boat trains in connection with the *Norddeutscher Lloyd* and *P. & O.* liners.

They join the rakes from Paris at Châlons-sur-Marne and Chaumont respectively.

c) The Franco-Italian trains of the *Nord* and *P.L.M.* Railways have of necessity to run via Paris, where they enter the terminal stations of each of these Companies. This is the case of the « Rome Express » to Naples (and Florence), which is extended to Sicily during part of the year.

The same two Companies also cover the running of the trains to the Riviera : the « Calais-Méditerranée Express » via Ventimiglia and San Remo, and the « P. and O. Express » which leaves the *Nord* system at La Chapelle-Charbons and runs into the Gare de Lyon (which at one time it avoided) whence it continues to Marseilles Arenc·

d) There is no longer any through train from Calais to the *Paris-Orleans* and *Midi* systems. The « Sud Express » gave this service for some time, but it now starts from Paris.

Ostend is the terminus of the « Ostend-

Vienna Express », the « Nord Express » and the « Ostend-Cologne Express », which all three follow the same route as far as the German frontier. In 1904 an « *Ostend-Switzerland Express* » ran for a short time but was not very successful.

2. In France there is a whole series of **short-distance boat trains**, composed of rolling stock belonging to the railway companies, and in which, during day journeys, dining or saloon cars and, during night journeys, sleeping cars belonging to the *Sleeping Car Co.* are included.

There are first of all the special transatlantic boat trains from Paris to the ports of Boulogne, Havre, Cherbourg, or Bordeaux (1).

Then there are the trains from Paris to Marseilles Joliette, in connection with the boats to Algiers, and those from Paris (Austerlitz) and Bordeaux to Port-Vendres, in connection with the Algiers and Oran boats.

3. Finally there are **long distance trains** which enable passengers and mails from overseas to pick up the boats at Lisbon, Marseilles or at the Italian ports of Genoa, Naples, Syracuse, Taranto, Brindisi and Triest.

The longest roundabout maritime route is that of the boats from England to India or Australia via Gibraltar; consequently various ways of shortening this interminable journey have been tried. In fact, it was for this reason that Stephenson built the first Egyptian railway from Alexandria to Cairo and Port-Said in order to substitute the « Overland Route » through Egyptian territory for the sea voyage round Africa.

A similar procedure was later followed in Europe. For this purpose, a postal service between Marseilles and Alexandria was established, which was the first in date and has served as the prototype for all the services which have succeeded it. It then became possible to embark at Marseilles instead of Falmouth or London.

A further improvement was the opening of the maritime service between Brindisi and Alexandria, which again shortened the sea route and increased the land journey by as much, thus enabling nearly a week to be saved as compared with the journey by sea all the way.

The *Sleeping Car Co.* was obviously the organisation to deal with the working of these exceptional services over the systems of various railway companies. The « Calais-Nice-Brindisi » is the oldest of these kind of trains.

In 1890 the Company substituted the PENINSULAR AND ORIENTAL EXPRESS, made up of coaches built in America and England, for the old « Malle des Indes », to which, up to that date, they had been satisfied to add one coach.

On the outward journey it followed a fixed timing, and on the return journey it had the choice of a certain number of

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(1) Trains to Boulogne in connection with the North American liners of the *Hamburg Amerika Linie*, the *Norddeutscher Lloyd*, the *Holland American Line*, and to South America, the *Royal Mail Lines*, the *Blue Star Line*, and the *Hamburg Süd Amerikanische*.

In connection at Cherbourg with the boats of the *Norddeutscher Lloyd*, the *Hamburg Amerika Linie*, the *White Star Line*, the *Canadian Pacific Lines*, the *Cunard Line* and the *Royal Mail Lines* to South America.

In connection at Havre with the boats of the *Cunard Line*, the *Compagnie Générale Transatlantique*, the *Red Star Line*, and the *United States Lines*, and, for Central America, with those of the *Compagnie Générale Transatlantique*.

Finally, dining or sleeping cars between Paris and Bordeaux, in trains connecting with the boats of the *Compagnie Générale Transatlantique*, for Central America, and those of the *Chargeurs Réunis*, for South America.

timings, according to the hour of arrival of the liner. It was essentially a mail train for India, with sleeping berths for 60 passengers. It was doubled, when necessary, by a first part carrying nothing but the mails, but usually the two parts of the train ran as one. The « P. and O. Express » ran until the War.

As soon as possible, a fast maritime service was re-established from Brindisi to the East, but this time the connection was covered by an extension of the « Rome Express » from Caserta to Brindisi via Foggia and thence by the old route of the « Peninsular and Oriental ». The embarkation point was soon put back at Taranto, but it was no longer a question of a service to India but to the Near-East; consequently soon after the « Orient Express » was re-established, this extension of the « Paris-Rome » was abandoned.

In spite of this, it is interesting to mention these special services, even though merely temporary, because, in many cases, they were the embryo of other more permanent services.

However, if the « P. and O. Ltd. Express » was killed by the War, this did not happen to the BOMBAY-MARSEILLES EXPRESS which is now the only train especially intended to assure the transport of the Indian mails.

Before the War, it avoided Paris altogether by running over the outer Ceinture Railway, but at the present time it runs into the Gare de Lyon.

The extension of the « Paris-Rome » to Syracuse fulfilled in fact, as far as passengers for Egypt were concerned, a role similar to that played by the previous trains, and like that of the so-called « Triest Express » which was, in actual fact, nothing more than a rake from the « Ostend-Vienna » giving correspondance with the *Lloyd Triestino*'s boats.

Two « de luxe » trains in a similar fashion put the large German towns into direct communication with the Mediterranean boats. There was the EGYPTIAN EXPRESS from Berlin to Naples, via the Brenner, which followed but with a different timing the route taken by the « Nord-Sud (Brenner) Express », and the LLOYD EXPRESS from Altona, Hamburg and Bremen to Genoa (via Cologne, Strasbourg and the Saint-Gothard) which was in connection with the *Norddeutscher Lloyd's* boats at Genoa.

At the present time, there is another train of this kind running between The Hague, Brussels, Paris (*P. L. M.*) and Marseilles, which is also called the « Lloyd Express », but which belongs (except for the sleeping and dining cars) to the railway companies concerned. It runs every three weeks in direct connection with the *Koninklijke Hollandsche Lloyd*'s boats.

XVIII-6. — **Holiday-resort and watering-place trains.** — As the Company's great express trains are intended above all for well-to-do passengers, convenient services for going to the watering places and holiday centres had to be set up, which was done in various ways, according to the importance of the traffic flowing to each of these places.

1. Thus, Montecatini and Aix-les-Bains are directly served by the great expresses passing through them.

2. On the other hand, one or more special coaches for the watering places, at some distance from the main lines served for other reasons, are detached from the trains.

TABLE 114.

RAKES SERVING WATERING PLACES OR TOURIST DISTRICTS.

JUNCTION OR DEPARTURE STATION.	DESTINATION.	Distance Km.	Distance Miles	« DE LUXE » TRAINS.
La Négresse	Biarritz.	3	2	Sud Express.
Do.	Do.	3	2	Pyrénées-Côte d'Argent Exp.
Bozen	Merano.	32	20	Nord-Sud (Brenner) Exp.
Wurzburg	*Bad Kissingen.*	67	42	Ostend-Vienna Express.
Schwarzach S. Veit . .	*Bad Gastein.*	20	12	Arlberg-Orient Express.

3. Certain trains which serve tourist districts, have a special rake for some watering place in the country :

Constantza	Carmen Sylva.	16	10	Rapide Regele Carol I.
Lourdes	Pierrefitte.	21	13	Pyrénées-Côte d'Argent Exp.
Bellegarde	*Evian-les-Bains.*	78	48	*Savoie Express.*

4. Finally the two great spas, Vichy and Carlsbad, have an importance which justifies the running of special trains to each of them :

Paris P. L. M.	*Vichy.*	365	227	*Vichy Express.*
Nuremberg	Carlsbad.	203	126	Ostend-Carlsbad Express.
Paris	Do.	1 041	646	Paris Prague-Carlsbad Express.
Berlin	Do.	413	257	Berlin-Carlsbad Express.

The VICHY EXPRESS, a saloon train before the War, and since then a Pullman train, started from Boulogne, where it met the London connection, but was restricted to the Paris-Vichy run only, before disappearing as an independent train.

Fig. 78. — The Carlsbad (Karoli Vary) express trains.
From Ostend, Paris and Berlin.

The Berlin-Carlsbad Express, like the special rake of the « Ostend-Vienna Express », is made up of two portions which separate at Eger, one of them running to Carlsbad, and the other to Marienbad (31 km., i. e. 19 miles away). Unlike what might be expected, these trains follow different timings, even over the common section. It is the same with the « Paris-Carlsbad-Prague » which serves Marienbad on the way, it being found sufficient to detach from it a rake for Prague.

Since the War, French and English patients have preferred Vichy to Carlsbad — now called Karoly-Vary — so that there is no longer any need for this rake. On the other hand, it was important to have direct communication between Paris and Prague. For the time being, such services were confided to the « Orient Express » in spite of the way about via Linz, whence a portion was sent to Prague. The distances by the two routes are as follow :

Paris-Nuremberg-Prague: 1 240 km. (771 miles).
Paris-Linz-Prague: 1 492 km. (927 miles).

As soon as the through train could be re-established, it was given in its turn the task of covering the services that could not be restarted as yet across Germany, and to serve Warsaw, until such time as the « Nord Express » could be run once more. It was extended by 698 km. (434 miles) from Prague to Warsaw, which only increased the journey from one end to another by 308 km. (191 miles), but improved it as compared with the first temporary connection at Vienna.

It has naturally been abandoned since, but a Stuttgart-Francfort portion has been added.

During the prosperous years, a Côte Belge Express was run from Paris to Ostend and Knocke, as well as a Trouville Express, both of which were Pullman trains, the latter taking the place of a former day train run by the Company, dating from the beginning of the century.

5. **Holiday districts** are served in the same way as the watering places, and the important trains which run through them frequently stop at such places, even if they are running at high speeds before getting there, and beyond.

Table 115.

A FEW EXAMPLES OF « DE LUXE » TRAIN SPEEDS
while running through holiday districts.

« DE LUXE » TRAIN.	RUN.	Time spent.	Distance		Speed		Number of intermediate stops.
			Km.	Miles.	Km/h.	Miles/h.	
Côte d'Azur	Paris Saint-Raphaël (I).	11 h. 42	1 021	634	87.2	54.2	7
	Saint-Raphaël-Mentone.	1 h. 33	81	50	52.3	32.5	6
Milan-Genoa-Nice-Cannes . .	Genoa-Cannes.	4 h. 58	208	130	41.8	26.0	17
	San Remo-Cannes.	2 h. 19	82	51	35.4	22.0	11
Pyrénées-Côte d'Argent . . .	Paris-Dax (I).	9 h. 51	736	457	74.6	46.4	6
	Dax-Irun.	2 h. 12	94	58	42.7	26.5	5
Simplon-Orient Express . . .	Arona-Lausanne.	4 h. 23	242	150	55.2	34.3	7
	Lausanne-Paris (I).	7 h. 35	527	327	69.5	43.2	4

In table 115 we have quoted, for comparison purposes, other runs effected by the same trains [those marked (1)].

6. There are special trains to the large areas so aptly named by the English « Europe's playgrounds » which are (from West to East): the Basque Coast, the Pyrenees, the Riviera and Savoie as far as France is concerned (we have not included either the Côte d'Emeraude nor Brittany neither of which are served by trains run by the *Sleeping Car Co.*), the Bernese Oberland and the Engadine in the case of Switzerland, the Lakes and Sicily in Italy, and the Tyrol, and also Egypt.

The Pyrénées-Côte d'Argent Express has succeeded the former « Côte Basque Express ». It is the night replica of the « Sud Express » which is a day train in France, and, like this latter, it includes a through coach for Biarritz. It includes a Dax-Pau-Pierrefitte portion and Dax-Pau-Tarbes section.

The Savoie Express was a day train, the three sections of which used to serve Geneva, Evian-les-Bains and Chambéry. The « Simplon-Orient » partly fulfils the same function.

The Riviera is the land of lands for convalescents or pleasure-seekers, and it is served by a whole series of « de luxe » trains coming from a dozen of the most important capitals of the Continent, which we have shown graphically in figure 79. They follow two traffic currents: the western current flows to Marseilles, then goes up to Lyons where it divides up into a fork, one half of which flows to Paris and the other to Strasbourg; the eastern current to Genoa has only a limited development in France.

The « Calais-Méditerranée » and the « Côte d'Azur » follow the first of these routes towards Paris, and formerly a « Riviera Express » went to Strasbourg and Berlin; three other « de luxe » trains one of them a Pullman train, run towards Italy today. This list is, moreover, very far from being complete, as apart from the sleeping-car services to Lyons and Paris on the one hand, to Lyons, Lausanne or Karlsruhe on the other, there is a sleeping-car service from Cerbère to Genoa and two services from the Riviera towards the East, one to Berlin and the other to Florence.

In addition, the *P. L.M.* has two « lits-salon » services and four « couchettes »-car services to Paris, without counting its services to Strasbourg, Geneva, Hendaye, Bordeaux and Vichy.

As far back as 1876, the Company had established a sleeping-car service between Paris and Mentone, and though it added the « Calais-Nice-Rome Express » (later transfered to the Simplon) it created the Méditerranée Express which it extended as far as Calais. Subsequently this train had to be duplicated (in 1926), and the Côte d'Azur Rapide (1930) had to be made up of Pullman stock. Finally, between Paris and Nice, there has been added a train made up entirely of 1st and 2nd-class sleeping cars.

The same route was followed from the Riviera to Lyons by the Lloyd Express, which then turned aside to go to Strasbourg and Berlin, with sections for Amsterdam and The Hague (via Utrecht).

The Lloyd Riviera Express has just been established between Berlin and Cannes, via Verona, under the name of « Riviera Express ». As before, it is composed of two portions, which separate at Milan, one going to Cannes and the other to Rome and Naples, but from Francfort to Basle it follows the right

Fig. 79. — The Riviera great expresses.

« Calais et Paris-Méditerranée Express » and « Côte d'Azur Rapide ».
« Lloyd-Riviera Express » and « Nord-Sud (Brenner) Express ».
« St-Petersburg-Vienna-Nice-Cannes Express » and « Vienna (Budapest) Tyrol Express ».
« Rome-Florence-Cannes Express ».

instead of the left bank of the Rhine which it has left since Alsace was restored to France.

The distance between Cannes and Berlin is 1 630 km. (1 013 miles), while it was 1 788 km. (1 111 miles) by the Lyons-Strasbourg route formerly followed. Together with the trains for the East, these are the only ones which follow two different routes to a common destination.

Before the War, there were two « de luxe » trains from Vienna to the Riviera.

The Vienna (Budapest)-Tyrol-Cannes Express had, as its name indicates, a double object, as it served two popular tourist regions. At Bozen it picked up the route followed by the « Nord-Sud (Brenner) » though it ran independently of this train.

The second train, the Vienna-Nice-Cannes, which served Verona, only follow-

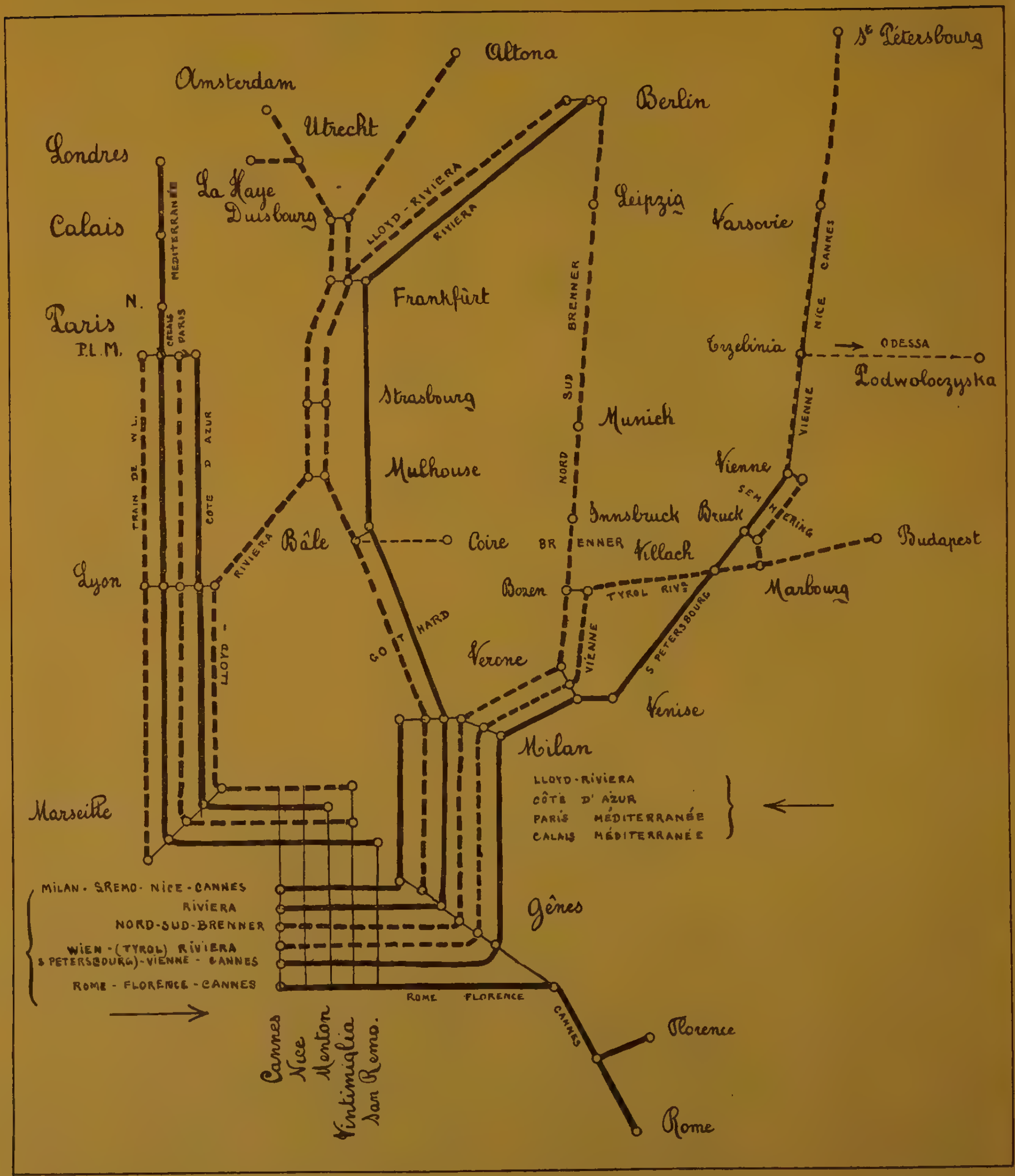


Fig. 80. — Chart of the Riviera great expresses.

ed the same route after Milan. At one time it was extended to Saint-Petersburg with through coaches for Podwoloczyska, in order to cover the connection for Odessa.

Now that this extension has been suppressed, the train includes through coaches for Munich and Warsaw.

The distance from Vienna to Milan, by the two routes, differs by a hundred kilometres (60 miles). It was :

1 003 km. (623 miles) via the Tyrol;
907 km. (563 miles) via Venice.

The two trains we have just quoted are duplicated at present by a Pullman train over the 372 km. (231 miles) between Cannes and Milan.

Finally the CANNES - FLORENCE - ROME EXPRESS covers the services to the South of Italy. If the Company's seven sleeping-car services and the twelve services run by the *P.L.M.* are taken into consideration, there is nothing excessive in saying that the Riviera is the best served district in all the World as regards direct international communications and sleeping-car services.

Switzerland is also served in an interesting way. First of all there was a SWITZERLAND EXPRESS which ran between Calais and Lucerne as from 1890, but the service given in this way was very incomplete.

The OBERLAND-ENGADINE EXPRESS. — The Oberland, the Engadine and the Lake of Lucerne, three of the chief holiday resorts in Switzerland, are connected to Paris and London by through « de luxe » trains, which join up at Belfort and separate again at Chaumont (181 km. = 112 miles further on) into two portions, one of which continues on to Paris Est, and the other to England, via Laon and Calais (or Boulogne).

The « Engadine Express » which ran between Paris and Chur, where the standard-gauge track comes to an end, has a section for Lucerne, which was detached at Basle.

Before the War, the « Oberland Express » was a *P.L.M.* train from Calais to Interlaken via Paris, Dijon and Pontarlier. The distance covered was 632 km. (393 miles) from Paris P. L. M. and 940 km. (584 miles) from Calais. Since the Armistice, this train has been transferred to the *Est* system, the distance by this route, via Delle and Délémont, being 652 km. (405 miles) from Paris, but only 909 km. (565 miles) from Calais.

This competition between two French systems for the Franco-Swiss traffic has extended to the Franco-Italian services also (the « Paris-Rome ») and is even found on a few isolated services. Thus, the sleeping car running from Paris P. L. M. and Paris Est to Brig, in the first case, cover a distance of 655 km. (407 miles) in 10 hours via Vallorbe and Lausanne, and in the second case 706 km. (439 miles) in 13 h. 5 m. via Belfort and Berne.

For some time, not only have the « Engadine » and the « Oberland Express » been amalgamated, but, though their name has been retained, they are only simple rakes of the « Arlberg Orient Express ». After having picked up at Chaumont the portion from Boulogne, it drops the « Oberland » section at Belfort and the « Engadine » portion at Sargans.

An OSTEND-SWITZERLAND and AMSTERDAM-SWITZERLAND EXPRESS, started in 1904, only lasted a very short time, and were replaced by a portion of the « Lloyd Riviera Express » linking up the large northern centres (Amsterdam, The Hague, Hamburg and Berlin) with Basle,

whence a portion branched off to Chur and another crossed the whole of Switzerland via the Saint-Gothard line to Milan and Genoa.

XVIII-7. — **The great day-time express trains : saloon cars and Pullman cars.** — It is mainly at the beginning of the century that the *Sleeping Car Co.* completed its « de luxe » train services by other trains made up of saloon cars and a dining car, most of such trains being necessarily limited to services within the frontiers of a country (cf. table 116).

We have previously dealt with the « Club Train ».

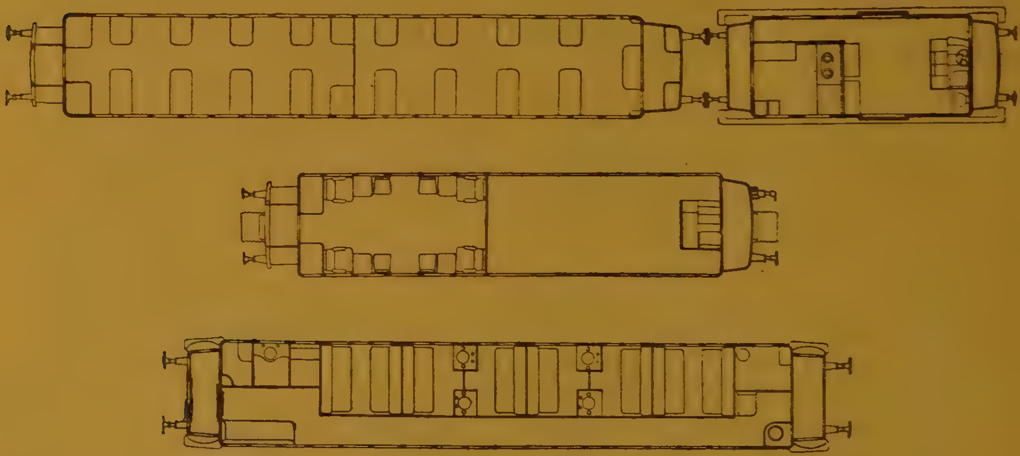


Fig. 81. — « Club train » carriages in 1889.
Top: England. — *Middle and bottom:* France.

The Amsterdam-Mons Express was introduced to run as far as this terminus — which was not really a terminal station — in the hope that the *Nord Railway* would extend it over its own system as far as Paris. This however was not done, and the train hardly lived longer than the « Club Train ».

Since the interpenetration of the *International Sleeping Car Company* and the English *Pullman Company*, the happy idea of introducing Pullman trains on the Continent was taken up; however, as we wrote at the time, more haste than speed was made. The travelling habits of the whole of the clients cannot be suddenly changed and it takes time to set up new and lasting traffic currents, after the first impulse of curiosity has been satisfied. Out of the many Pullman trains that were introduced, one after the other, the principal among which we have mentioned, only a dozen have survived.

Among these are the « Sud Express », the « Côte d'Azur » and the « Andalousie Express », which are really older trains now made up of Pullman coaches.

CHAPTER XIX.

The rolling stock.

XIX-1. — **Rolling stock with wooden bodies.** — The first « voitures-lits »,

TABLE 116.

ALL-SALOON-CAR AND ALL-PULLMAN-CAR TRAINS OF THE SLEEPING CAR Co.

COUNTRY.	NAME OF TRAIN.	RUN	Distance Km.	Distance Miles.
SALOON TRAINS (All obsolete).				
England.	Club Train.	London-Dover.	125	78
France.	Do.	Paris-Calais.	299	186
	Paris-Trouville	Do. -Houlgate.	240	149
	Paris-Cabourg.	Do. -Cabourg.		
	Paris-Vichy.	Do. -Vichy.	365	227
		— Royat branch.	65	40
	Savoie Express	Paris-Geneva.	605	376
		— Bellegarde-Evian branch.	78	48
		— Culoz-Chambéry branch.	36	22
Spain.	Andalousie Express.	Madrid-Sevilla.	574	357
Holland-Belgium.	Amsterdam-Mons Express . .	Amsterdam-Mons.	295	183
PULLMAN TRAINS (Obsolete runs are shown in italics).				
France.	*Trouville Express*	*Paris-Trouville-Deauville.*	221	137
	The Golden Arrow.	Paris-Calais Harbour.	299	186
	London-Vichy Pullman Exp. .	*Boulogne-Paris-Vichy.*	679	422
	Côte d'Azur Rapide	Paris-Mentone.	1 108	689
	Sud Express	Paris-Irun.	841	523
Italy.	*Rome-Naples*	*Rome-Naples.*	214	133
		Milan-Ancona.	423	262
		Turin-Venice.	265	165
Spain.	Andalousie Pullman Express .	Sevilla-Grenada.	288	179
Switzerland.	*Golden Mountain Express* . .	*Montreux-Zweisimmen.*	62	39
Rumania.	*Carpati Pullman.*	*Bucarest-Sinaïa.*	126	78
	Dunarea Pullman	Do. -Galaiz.	260	162
	Rapide Regele Carol I. . . .	Do. -Constantza.	227	141
France-Belgium.	Brussels-Calais	Boulogne-Brussels.	260	162
	Do.	Brussels-Calais.	217	135
	Blue-Bird	Paris N.-Antwerp.	362	225
	Côte Belge Pullman	*Paris-Ostend.*		
Fr.-Belg.-Holl.	Etoile du Nord	Paris- N.-Amsterdam.	539	335
Holland-Belgium. France-Switzerl.	Edelweiss	*Amsterdam-Basle-Zurich.*	884	549
	Do.	— Basle-Lucerne branch.	96	60
Belgium-Germany.	Ostend-Cologne	Ostend-Cologne.	346	215
Italy-France.	Milan-San Remo-Cannes . . .	Milan-Cannes.	372	231
Italy-Switzerland.	*Gothard Pullman*	*Milan-Basle.*	371	230
		— *Arth Goldau-Zurich branch.*	49	29

built in 1872, were four-wheeled vehicles with eight berths arranged longitudinally; at night the seats opposite each other were pulled together and the backs lowered to form the lower berths; the upper berths were pulled down from above, and pushed back for the day service. For a long time the « voitures-lits » were four or six-wheeled vehicles; they contained compartments with two or four berths (fig. 66).

Soon, however, transverse berths were substituted for the longitudinal ones. Lighting by colza oil gave place to oil-gas; first steam heating, then low-pressure hot water heating took the place of stoves burning briquettes.

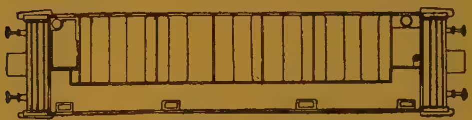


Fig. 82. — First sleeping car with gangway.

The wheel base was 4.40 m. to 5.20 m. (14 ft. 5 in. to 17 ft. 1 in.) and teak-centre Mansell wheels were fitted. The total wheel base of certain 6-wheeled coaches was as long as 7.50 m. and even 9.50 m. (24 ft. 7 in. to 31 ft. 2 in.).

In order to provide « de luxe » trains with intercommunication, the Company built, in 1880, corridor sleeping cars with open platforms and gangways. These vehicles contained from 12 to 14 berths; some of them, however, only had 6 or 8, and a saloon with some ordinary 1st or 2nd-class seats; their wheel base was 6.70 m. (22 feet). This is how the saloon (drawing room) cars originated.

In order to increase the comfort of the passengers in the projected great express trains, the Company invented the dining car. The first tests were made with three six-wheeled 3rd-class coaches belonging to the *Anhalt Railway*, which were rebuilt for this purpose and ran between Berlin, Bebra and Francfort (fig. 68).

The utility of such stock was recognised, but not in the form provided. The luncheon baskets provided for the passengers were not very appetising; moreover, the coaches ran unsteadily and this inconvenienced the diners. Consequently a kitchen had to be added and the spring gear altered.

In 1880, the Company decided to build (fig. 69) a trial bogie sleeping car; this was the first bogie vehicle on the Continent, but, incredible as it seems, the Company had the greatest difficulty in getting the railways to let such stock run over their systems. It ended by gaining its point and obtained permission to use bogie rolling stock for its first great international train: the « Orient Express » which then only ran between Calais, Paris and Budapest, as the Serbo-Bulgarian connection had not yet been built. Very soon a bogie dining car was included to replace the old six-wheeled vehicle. Finally the open platforms were replaced by covered-in platforms and bellows were added, as in America.

We will not go into detail here about the different alterations made to these vehicles as time went on. The wood used was teak; the bogies of 2.50-m. (8 ft. 2 7/16 in.) wheel base, and made of iron and wood originally, were soon replaced by steel bogies; the distance between bogie centres was increased from 10.90 m. to 11.20 m. (35 ft. 9 in. to 36 ft. 9 in).

Another curious point is that the adoption of the continuous brake increased the tare weight by more than 3 1/2 tons, as it necessitated the replacement or strengthening of many parts.

The sleeping cars contained 16 to 20

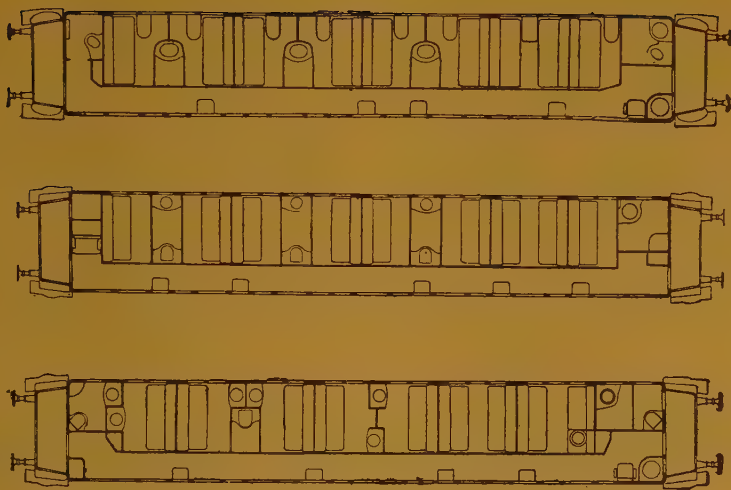


Fig. 83. — Sleeping car of the « Méditerranée Express », the « Nord Express » and the « Ostend-Vienna ».

Fig. 84. — Early XXth-Century dining cars and vans.

berths, often 18. The dining cars consisted of two compartments, and contained 30, 36, or 40 seats, 50 in exceptional cases, Finally the Company put into service saloon cars, one compartment of which was often used as a restaurant (fig. 83 and 84).

We have shown above, figs. 66, 68 to 70, also 81 and 83, the main stages of evolution of the sleeping and dining cars, and we have drawn diagrams to the same scale as that of the coaches which are reproduced here.

The sleeping cars on the « Ostend-Vienna Express » were the first to be fitted with lavatories and W. C. in between the compartments. In succeeding stock, intended for the « Méditerranée

Express » the lavatories were retained, but the W. C.'s put at each end of the corridor.

The first buffet-cars for short journeys were also introduced at this peroid.

The main dimensions of the different classes of carriage were the same, but their internal arrangement differed. One single important innovation was introduced in 1898, in the sleeping-cars for Egypt : the two berths in each compartment were arranged at right angles to one another, which enabled the upper berth to be lowered and avoided the berths being superimposed.

The use of Stone's lighting, first tried in 1898, spread very rapidly. Mechanical or electrical ventilation was introduced in 1901.

In 1905, a certain number of sleeping and dining cars with six-wheeled bogies were built and soon followed by carriages

Fig. 85. — Dining cars and sleeping cars with six-wheeled bogies.
Large-wheelbase sleeping car with transverse berths.

(for the *Paris-Orleans*) on four-wheeled bogies of 3-m. (9 ft. 10 1/8 in.) wheelbase. Their total length was 23.45 m. (76 ft. 11 in.) instead of 21.15 m. (69 ft. 5 in.) as in the previous vehicles. This length was a striking innovation at the time, though today it has become current practice. The tare weight of these vehicles increased from 50 to 53 tons.

Saloon cars. — For the day time services the Company built saloon cars, the first of which ran during the 1889 Exhibition, both in the « Club Train » and in the afternoon fast express trains from Paris to Bordeaux. Although these were soon converted into dining cars, the new services introduced after 1901, Paris-Trouville, the « Sud Express », etc., were more successful.

The *Belgian State Railways* no longer providing 1st-class carriages, the *Sleeping Car Co.* was able to introduce in their trains some 50 saloon-car services.

Although these vehicles were bought up later on by the State, the Company still worked them.

In table 117, we give the principal dimensions of the most important types of such carriages, as well as those of the present-day all-metal vehicles.

XIX-2. — **All-metal coaches.** — As from 1922, the *Sleeping Car Co.* made a radical change in the type of rolling stock used, and adopted all-metal vehicles, in spite of the increased weight per seat this meant. The rolling stock was redesigned and was simplified very successfuly both inside and out, the bogies being of steel cast in one piece. The principal dimensions however remained the same as before (fig. 86).

The first series of these vehicles were built in England by the Leeds Forge Co. and sent to the Continent by the Harwich-Zeebrugge ferry boats. Since then, several Works on the Continent have adapted their equipment so as to be able to also build this new stock.

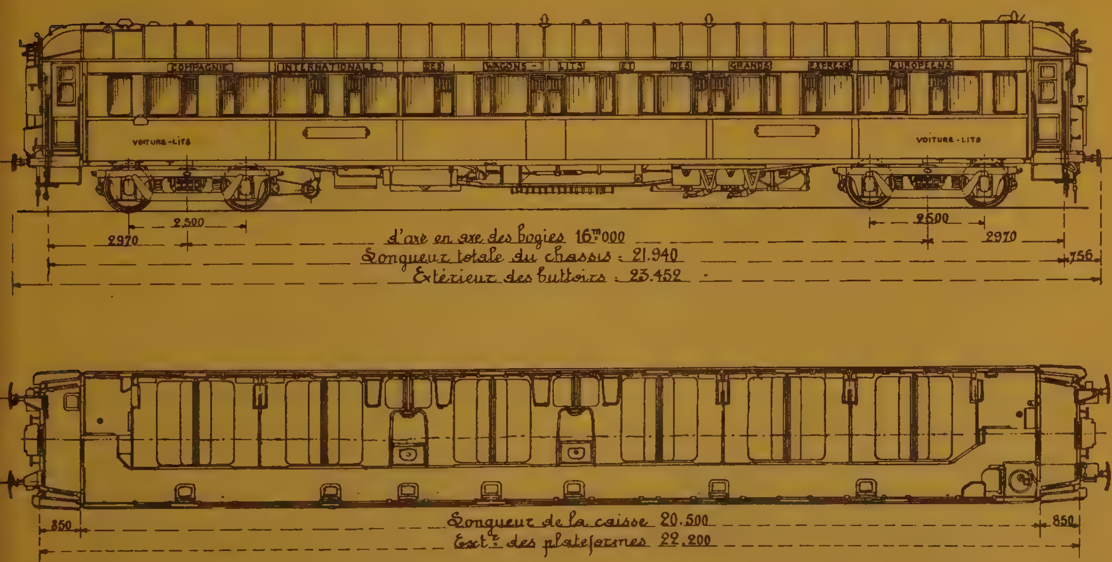


Fig. 86. — All-metal sleeping cars.

Note: D'axe en axe des bogies = Distance between bogie centres. — Longueur totale... = Length over headstocks. — Extérieur des buttoirs = Overall length. — Longueur de la caisse = Body length. — Extérieur des plateformes = Over headstocks.

The all-metal sleeping cars for the « Blue Trains » are of different types:

Sleeping cars with 16 berths, i. e. with 8 single-berth compartments, and 4 two-berth compartments;

Luxury sleeping cars, with 10 single-berth compartments, which run in the « Calais » and « Paris-Mediterranean Express » and in the « Pyrénées-Côte d'Argent Express »;

Sleeping cars with 24 berths, having 12 first and 12 second-class compartments with intermediate Z-shaped partitions;

TABLE 117.

PRINCIPAL DIMENSIONS OF SLEEPING CARS, DINING CARS AND SALOON CARS, showing the main stages of development of the Sleeping Car Co.'s rolling stock.

Date.	Kind of carriage.	Seats provided.	Length. Body.	Length. Overall.	Number of wheels.	Distance between bogie centres. (1)	Tare Metr. (*Engl.*) tons.	—
1872	Sleeping car.	12	7.90 m. (*25'11"*)	9.09 m. (*29'10"*)	4	4.60 m. (*15'1"*)	13.8 (*13.6*)	
1873	Sleeping car.	16	11.08 m. (*36'4"*)	12.38 m. (*40'7"*)	6	6.88 m. (*22'7"*)	19.2 (*18.9*)	
1883	Sleeping car.	20	14.12 m. (*46'4"*)	16.84 m. (*55'3"*)	8	10.90 m. (*35'9"*)	27.5 (*27.0*)	Orient Express.
1885	Dining car.	36	Do.	17.02 m. (*55'10"*)	8	Do.	27 (*26.6*)	Do.
1889	Saloon car.	48	15.79 m. (*51'10"*)	18.63 m. (*61'1 1/2"*)	8	11.90 m. (*39'1 1/2"*)	26.5 (*26.0*)	Club Train.
Do.	Rest.-Van.	8	11.50 m. (*37'9"*)	13.96 m. (*45'10"*)	8	8.00 m. (*26'3'*)	23.0 (*22.6*)	Do.
1892	Sleeping car.	20	16.34 m. (*53'7"*)	19.26 m. (*63'2"*)	8	12.50 m. (*41'0"*)	29.1 (*28.6*)	P. and O. Express.
Do.	Dining car.	37	15.70 m. (*51'6"*)	18.52 m. (*60'9"*)	8	12.00 m. (*39'5"*)	31.0 (*30.5*)	Do.
Do.	Sleeping car.	17	16.43 m. (*53'11"*)	19.37 m. (*63'6 1/2"*)	8	12.50 m. (*41'0"*)	35 (*34.4*)	Ostend-Vienna Express.
1901	Saloon car.	30	16.80 m. (*55'1 1/2"*)	19.74 m. (*64'9"*)	8	13.20 m. (*43'4"*)	37.8 (*37.2*)	Sud Express etc.
	Sleeping car.	17	18.21 m. (*59'9"*)	21.15 m. (*69'5"*)	12	14.50 m. (*47'7"*)	50.0 (*49.2*)	
	Dining car.	40	17.46 m. (*57'3"*)	20.40 m. (*66'11"*)	12	14.15 m. (*46'5"*)	49 (*48.2*)	
1908	Sleeping car.	18	20.50 m. (*67'3"*)	23.45 m. (*76'11"*)	8	15.00 m. (*49'3"*)	53.5 (*52.7*)	Paris-Orleans.
1922	Sleeping car.	16	Do.	Do.	8	16.00 m. (*52'6"*)	53 (*52.2*)	
1926	Pullman.	32	Do.	Do.	8	Do.	47.4 (*46.7*)	
Do.	Pullman.	24	Do.	Do.	8	Do.	51.0 (*50.2*)	
1929	Sleeping car.	10	Do.	Do.	8	Do.	...	

(1) Or wheelbase of 4- and 6-wheeled carriages.

Fig. 87. — Modern all-metal sleeping cars.
16-seater, high luxury 10-seater, and 1st and 2nd-class 24-seater types.

Sleeping cars with 22 berths in 11 compartments, with Z-shaped partitions, and fitted out so that light meals can be provided.

The dining compartments in the restaurant cars have been enlarged, which gives them a capacity of 56 seats in vehicles worked in other than the Company's trains, and 42 arm chairs on the « de luxe » trains.

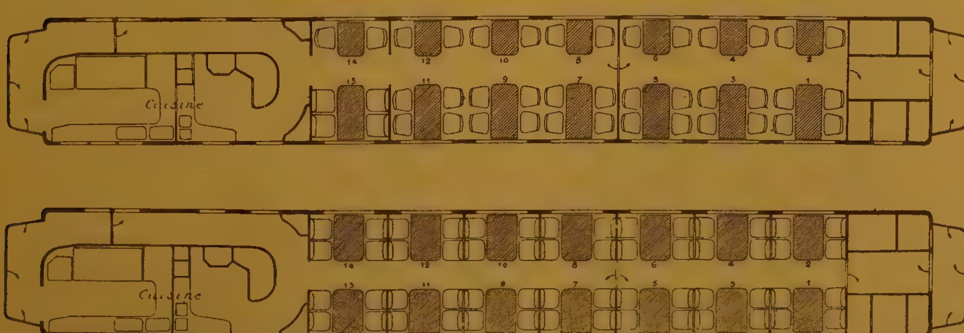


Fig. 88. — Modern all-metal restaurant cars with 42 and 56 seats.

The ALL-METAL BRAKE VANS have also been improved; some of them have been fitted with shower-baths. Others, which are used on the services between Paris and the Channel, are arranged to take Paris-London containers; this was the

first line on which such containers were used (fig. 89).

PULLMAN COACHES. — The first Pullmans were built by the *Leeds Forge Co.* for the new « Milan-Nice-Cannes Express », which was introduced on the 15th December, 1926. The two-car sets consisted of one carriage with, and one carriage without, a kitchen. Below we give their capacity (figs. 90 and 91):

1st-class Pullman without kitchen : 24 seats (Sud Express), 28 seats (Côte d'Azur), 34 seats (Golden Arrow);
1st-class Pullman with kitchen : 18, 20, 26 seats respectively for the above trains;
2nd-class Pullman without kitchen : 51 seats (Etoile du Nord);
with kitchen : 38 seats.

XIX-3. — **Rolling stock for other than standard-gauge lines.** — In addition to its stock for standard gauge lines, the Company also built stock for Russia, Spain and Portugal. The Russian stock for 1.52-m. (5-foot) gauge lines was built to more generous proportions than that used throughout the rest of Europe, but its design had to take into account the special climatic conditions of the country and the considerable mileage run by certain trains, such as the Trans-Siberian.

The Spanish carriages, for 1.67-m. (5 ft. 6 in.) gauge lines are considerably wider, and this has made it possible to provide a number of comfortable seats in the corridors of the sleeping-cars.

Finally, the Company introduced services on some narrow-gauge lines : Pullman services on the *Montreux-Berner Oberland Railway* metre-gauge lines; dining cars on the 0.95-m. (3 ft. 1 3/8 in.) gauge lines of the *Sardinian Railways;* sleeping cars and diners on the *Congo Railway, Bas Congo-Katanga Railway* and *Benguella Railways*, African railway systems of 1.067-m. (3 ft. 6 in.) gauge lines.

The consideration of this stock specially built for such and such a railway will be more in place when we are studying the country concerned, than here where we are dealing with international stock which can be used more or less anywhere in Continental Europe.

This also applies to standard-gauge rolling stock for tropical countries, specially designed for Egypt, and to the sleeping cars built by the Company to the English loading gauge, which will run between the Continent and Great Britain when the train ferries between Dover and Dunkirk will be in service.

XIX-4. — **Stock of vehicles.** — The maintenance of the great trains entails the use of a considerable amount of rolling stock, as it is not enough to have several distinct rakes to cover each service; there must also be spare vehicles at carefully selected points, in view of the fact that certain coaches have to be temporarily taken out of service for inspection and repairs. A centralised organisation such as the *Sleeping Car Co.* can, to a certain extent, decrease the number of supplementary vehicles in its reserve stock, but the total number of coaches will nevertheless be considerable.

We must remember, for example, that the « Simplon-Orient » takes two and a half days from Paris to Istambul, two days to Bucarest, and two and a half days to Athens, and this train runs every day.

The coaches which arrive at Istambul

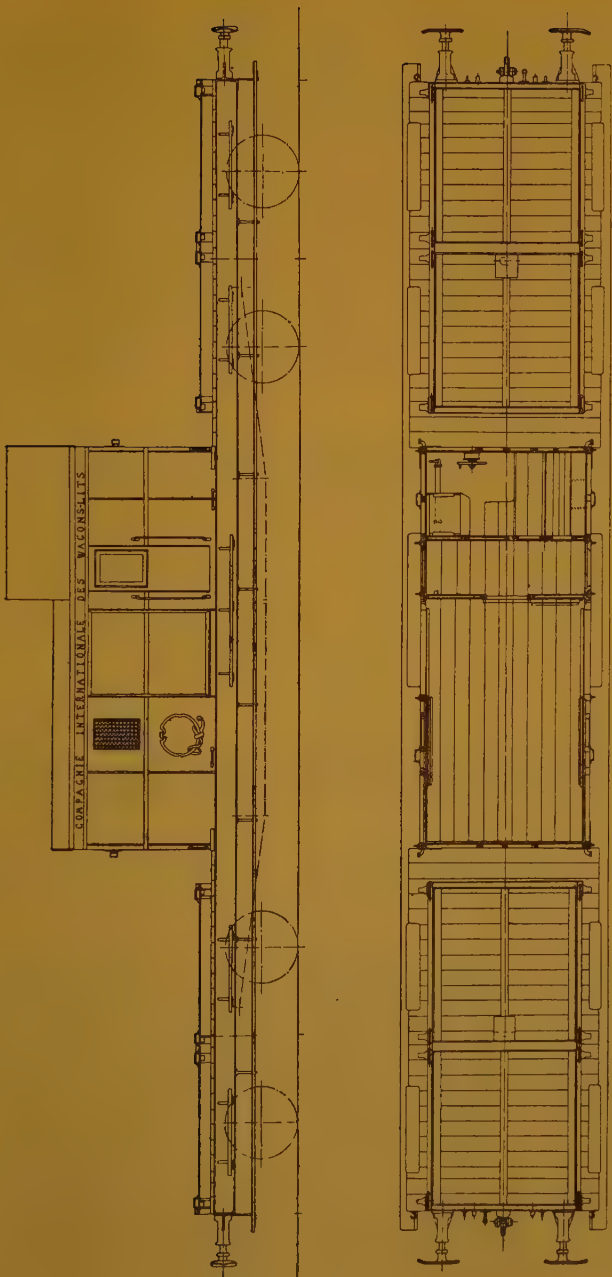


Fig. 89. — Container-carrying wagon (1929) of the Paris and London line.

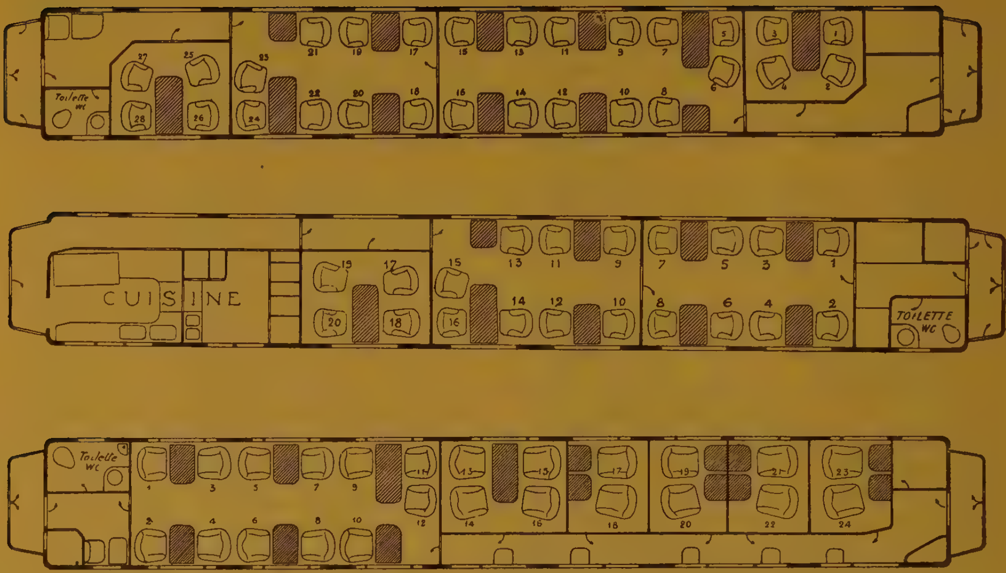


Fig. 90. — 1st-class Pullman with and without kitchen, of the « Côte d'Azur » and « Golden Arrow » type.

Fig. 91. — 2nd-class Pullman of the « Golden Arrow » and « Etoile du Nord » type.

in the morning leave for Paris the same evening, but only get there two and a half days later. If the run to Calais is added to this (and some of the coaches start from there) it will be seen that they only return to their starting point on

TABLE 118.

SHOWING HOW THE « SIMPLON-ORIENT EXPRESS » AND THE « NORD EXPRESS » ARE MADE UP.

SECTION.	Vans.	Dining cars.	Sleeping cars.	Sleeping-car services.
Simplon Orient Express.				
Paris-Vallorbe	2	1	5	Calais-Istambul. Paris-Istambul or Belgrad. Calais-Triest, in Summer. Paris-Athens. Do. -Bucarest.
Vallorbe-Domodossola				Do. less the dining car.
Domodossola-Triest				As for Paris-Vallorbe.
Triest-Vinkovci				Do. except Triest sleeping car.
Vinkovci-Belgrad				Do. except Bucarest sleeping car.
Belgrad-Istambul.	2	1	3	Calais-Istambul. Paris-Istambul (3 times a week). *or* Prague-Istambul. Berlin-Istambul (4 times a week). *or* Ostend-Istambul.
Nord Express.				
Paris-Liége	2	1	4	2 Paris-Berlin or Warsaw. 1 Do. -Hamburg. 1 Do. -Riga.
Liége-Hanover			+2	1 Calais. 1 Ostend.
Hanover-Berlin				*Less* Hamburg sleeping car.
Berlin-Warsaw	2	1	4	2 Paris-Warsaw. 1 Calais-Warsaw. 1 Ostend-Warsaw.

the sixth day and cannot leave again until the seventh. Consequently, six rakes must be maintained in service.

The *Sleeping Car Co.* has been good enough to give us some data on this subject, and we cannot do better, in order to give a concrete example, than to reproduce the information supplied in connection with two of the great European trains: the « Simplon-Orient Express » (which in addition requires stock for the Asiatic side) and the « Nord Express ».

We have shown the composition of these trains when they start and when their runs come to an end. Each of them has only one sleeping car less than in 1919-30, unlike the Pullman trains which have been much curtailed. Thus the « Etoile du Nord » which consisted of four coaches for Brussels and the same amount for Amsterdam now only has two coaches for Brussels and three for Amsterdam.

In table 119 we give the present composition of some of the other « de luxe » trains.

Table 119.

PRESENT-DAY COMPOSITION OF A FEW OF THE SLEEPING CAR CO.'S TRAINS.

NAME OF TRAIN.	Pullman. (55 t. = *54.1 Engl. tons*).	Sleeping cars. (55 t. = *54.1 Engl. tons*).	Dining cars. (56 t. = *55.1 Engl. tons*).	Vans. (38 t. = *37.4 Engl. tons*).	Total tare. Metric (*English*) tons.
Etoile du Nord	5	...	...	2	351 (*345.4*)
Blue Bird	4	...	...	2	296 (*291.3*)
Golden Arrow	4	...	...	2	296 (*291.3*)
Do. return journey	4	4	...	2	516 (*507.7*)
Sud Express (in France)	3	...	...	2	241 (*237.1*)
Nord Express	...	4	1	2	352 (*346.4*)
Orient Express	...	3	1	2	297 (*292.2*)
Simplon-Orient Express	...	5	1	2	407 (*400.5*)
Calais-Méditerranée	...	6	1	2	462 (*454.6*)
Rome Express	...	3	1	2	297 (*292.2*)

Fig. 92. — Converted sleeping cars.

a) Teak-bodied « lit-salon » with berths at a right angle.
b) Teak or metal-bodied 3rd-class sleeping car with 36 places in nine 4-berth compartments.
c) 1st (or 2nd) and 3rd-class sleeping car with 30 berths.

Since the merging of some of the trains in order to diminish the number of train-kilometres, sleeping-cars are run in some of the Pullman trains. In the Calais-Paris direction, the « Golden Arrow » includes two sleeping cars of the « Calais-Mediterranean Express » and two sleeping cars (sometimes only one) of the « Simplon Orient ».

The « Gothard Pullman » from Milan to Basle conveys a through sleeping car for Paris; the « Calais-Brussels Pullman » always includes a sleeping car which continues beyond Brussels in the « Nord Express ».

XIX-5. — **Converted vehicles.** — In order to overcome the disastrous effects of the crisis and to secure a new clientship with more modest incomes, the Company has now put its services within the reach of all purses (fig. 92).

For a long time, 2nd-class passengers were admitted in some of its sleeping cars. Today this measure has been extended to all the Company's services, even to important trains, and gradually the same thing is being done for 3rd-class passengers.

The 3rd-class sleeping cars are usually old 1st-class coaches subsequently converted into composite 1st and 2nd-class vehicles, in which the individual toilette compartments have now been suppressed, and three berths one above the other have been fitted instead of the two berths previously installed (fig. 93). Some of these coaches are composite 2nd and 3rd-class carriages, or even 1st, 2nd and 3rd-class, in which the 1st-class compartments only differ from the 2nd-class in that the passenger can have it to himself without additional cost.

Dining cars have in like manner been turned into travelling bars, in which simpler and cheaper meals are served. Consequently, it has been possible to simplify the equipment and install a long counter in one of the two compartments.

Following the same trend, all the French railway companies have followed the example of some companies in other countries and converted some of their carriages into buffet-cars worked by the *Sleeping Car Co.* This practice spread also to Belgium where the first restaurant-bar cars have been run since the 15th May, 1931, between Brussels and Luxembourg, and Brussels and Herbesthal.

Fig. 93. — Converted teak-bodied sleeping car.
3rd-class sleeping-car compartment with 3 superimposed berths.

After having in this way reviewed the economic role played by the *International Sleeping Car Company* in the different parts of Europe, there remains to examine more closely the organisation of its services and the speed of its trains in each of the countries where such services are run, as well as the local characteristics of each of them.

Thus, in the case of France, the trans-Paris services and the important cross-country services should be studied; as regards Germany, the relations between the *International Sleeping Car Company*'s services and those of the *Mitropa;* in the case of Belgium, the working of the old saloon coaches; in Spain and Russia, the Company's rolling stock for 1.67-m. or 1.52-m. (5 ft. 6 in. or 5 ft.) gauge lines; and so on.

The information about France will be found in Chapter XV, §§ 3 and 4 (pp. 451/195 to 459/203). Information about the other countries will be given later on.

(*To be continued*).

[621. 132.5 (.73)

4-8-4 type fast freight locomotives, Lehigh Valley Railroad,

by E. C. POULTNEY.

(*The Railway Engineer.*)

During the early part of 1931, the Lehigh Valley Railroad received two large locomotives for trial purposes, and built under guarantee to meet specific operating conditions, one by the American Locomotive Company, Schenectady, and the other by the Baldwin Locomotive Works, Philadelphia, Pa. The builders were invited to submit proposals for locomotives capable of working heavy fast 3 000-ton freight trains over the main line between Tifft Terminal (Buffalo, N.Y.) and the eastern terminus of the road at Oak Island (Newark, N.J.), a distance of 439 miles. A specific schedule was to be maintained, with a minimum of pusher assistance, together with economic operation. The general design was left to the builders, but the allowable, weights and general specifications were arranged in conference with the officials of the railway. In respect also to the detail design each builder conformed to the desires of the mechanical authorities who naturally considered that, as far as possible, interchangeability should be attained. The allowable weight on each pair of driving wheels was fixed at 67 500 lb., or 30 long tons, with a spacing of 77 inches. These two trial engines, numbered 5 100 and 5 200 for the Baldwin and American respectively, may be said to be fully representative of most modern practice in the United States in the design of high-powered locomotives.

Fig. 1. — 4-8-4 locomotive No. 5206, American Locomotive Company.

The table of the principal dimensions of the engines gives the leading particulars of the first two engines, Nos. 5100 and 5200, and for the 20 subsequently constructed, 10 by the American Locomotive Co. and 10 by the Baldwin Locomotive Works. For all practical purposes the latest engines are like the two originally built, the principal differences being that engines 5100 and 5200 were both equipped with the Elesco feed water heater, and with Walschaerts valve motion for the Baldwin, and Baker gear for the American, and had tenders with 18 000-gallon tanks and space for 56 000 lb., or 25 long tons of coal. Locomotive

Table I. — LEHIGH VALLEY « WYOMING » TYPE 4-8-4 LOCOMOTIVES.

Principal Dimensions.

<table>
<tr><th>Builder :</th><th colspan="2">Baldwin Locomotive Works.</th><th colspan="2">American Locomotive Company.</th></tr>
<tr><th>Road No.:</th><th>5 100</th><th>5 101</th><th>5 200</th><th>5 201</th></tr>
<tr><td>Cylinders, diameter and stroke . . . inches.</td><td colspan="2">27 × 30</td><td colspan="2">26 × 32</td></tr>
<tr><td>Valve gear . . . .</td><td>Walschaerts</td><td>Baker</td><td>Baker</td><td>Baker</td></tr>
<tr><td>Valves, diameter . . . . inches.</td><td colspan="2">12</td><td colspan="2">12</td></tr>
<tr><td>Wheels :</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Drivers, diameter . . . . —</td><td colspan="2">70</td><td colspan="2">70</td></tr>
<tr><td>Front truck . . . . —</td><td colspan="2">33</td><td colspan="2">33</td></tr>
<tr><td>Trailing truck : Front . . . . . . —</td><td colspan="2">42</td><td colspan="2">36</td></tr>
<tr><td>— — Hind . . . . . . —</td><td colspan="2">42</td><td colspan="2">45</td></tr>
<tr><td>Boiler :</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Steam pressure . . . . lb.</td><td colspan="2">250</td><td colspan="2">255</td></tr>
<tr><td>Tubes, No. and diameter. . . . . . inches.</td><td colspan="2">77—2 1/4</td><td colspan="2">77—2 1/4</td></tr>
<tr><td>Flues — — . . . . —</td><td colspan="2">202—3 1/2</td><td colspan="2">202—3 1/2</td></tr>
<tr><td>Length over tube plates . . . .</td><td colspan="2">21 ft. 6 in.</td><td colspan="2">21 ft. 6 in.</td></tr>
<tr><td>Heating surfaces :</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Fire-box and comb. chamber . . . sq. feet.</td><td colspan="2">490</td><td colspan="2">508</td></tr>
<tr><td>Tubes and flues. . . . . —</td><td colspan="2">4 932</td><td colspan="2">4 933</td></tr>
<tr><td>Total evap. . . . . —</td><td colspan="2">5 432</td><td colspan="2">5 441</td></tr>
<tr><td>Superheater . . . . —</td><td colspan="2">2 256</td><td colspan="2">2 243</td></tr>
<tr><td>Comb. total . . . . —</td><td colspan="2">7 678</td><td colspan="2">7 684</td></tr>
<tr><td>Grate area. . . . . —</td><td colspan="2">88.3</td><td colspan="2">88.3</td></tr>
<tr><td>Weight on drivers. . . . . lb.</td><td>270 000 = 120.5 tons</td><td>270 000 = 120.5 tons</td><td>268 000 = 119.5 tons</td><td>269 000 = 120.0 tons</td></tr>
<tr><td>— front truck . . . . —</td><td>55 000 = 24.5 —</td><td>60 070 = 26.8 —</td><td>65 200 = 29.1 —</td><td>65 000 = 29.0 —</td></tr>
<tr><td>— trailing truck . . . . —</td><td>83 000 = 37.1 —</td><td>83.100 = 37.1 —</td><td>88 800 = 39.81 —</td><td>90 000 = 40.15 —</td></tr>
<tr><td>Total engine. . . . . —</td><td>408 000 = 182.1 —</td><td>413 170 = 184.4 —</td><td>422 000 = 188.41 —</td><td>424 000 = 189.15 —</td></tr>
<tr><td>— tender . . . . —</td><td>366 200 = 163.5 —</td><td>398 330 = 177.9 —</td><td>358 800 = 160.0 —</td><td>389 100 = 173.30 —</td></tr>
<tr><td>— engine and tender . . . . —</td><td>774 200 = 345.6 —</td><td>811 500 = 362.3 —</td><td>780 800 = 348.41 —</td><td>813 100 = 362.45 —</td></tr>
<tr><td>Rated tractive force . . . . —</td><td colspan="2">66 400</td><td colspan="2">66 700</td></tr>
<tr><td>Tractive force, booster . . . .</td><td colspan="2">18 360</td><td colspan="2">18 360</td></tr>
<tr><td>Tender water, capacity . . . . gallons.</td><td>18 000</td><td>20 000</td><td>18 000</td><td>20 000</td></tr>
<tr><td>— coal — . . . . lb.</td><td>56 000</td><td>60 000</td><td>56 000</td><td>60 000</td></tr>
</table>

Note. — Weights given in pounds and tons of 2 240 lb. Tender water capacity, U. S. gallons.

No. 5100 had a weight of 774 200 lb., or 345 tons, and 5200 weighed 780 000 lb., or 348 tons.

In general, both locomotives are notably alike, both have the same sized drivers, viz., 70 inches, but the Baldwin engine had cylinders 27 inches by 30 inches and the American 26 inches by 32 inches. The steam pressures are 250 and 255 lb. per sq. inch, making the rated tractive effort for the Baldwin 66 400 and for the American 66 700 lb. These figures are increased by 18 360 lb. by the Bethlehem auxiliary locomotives fitted to the tenders.

The boilers of the round top radial stayed design are generally similar both in size and materials. Both have a combustion chamber, and tubes 21 ft. 6 in. long, there being 77—2 1/4 inch and 202—3 1/2 inch tubes, for the type E superheater. The boilers and fireboxes with combustion chambers are constructed throughout of nickel-steel and the inside firebox with the combustion chamber is welded complete. The crown and side sheets are in three pieces, with separate plates for the throat, tube, backplate, and combustion chamber. The outside wrapper is in three sheets. The inside diameter of the boilers is 84 9/16 inches for the Baldwin and 84 1/4 for the American, both have the same sized firebox, which is 132 1/8 inches by 96 1/4 inches outside, and in each case the grate area is 88.3 sq. feet. There are four Nicholson syphons, three in the firebox and one in the combustion chamber. Franklin Butterfly fire doors are fittel. Standard type BK mechanical stokers are fitted to all the locomotives. All the engines have feed water heaters, 5 American have the Elesco, and the other 15 are fitted with the Worthington S type. The Elesco arrangement as applied to the Baldwin engine, No. 5100, is well shown by the three-quarter view. The heater is carried on brackets in front of the smokebox, and the vertical duplex type CF reciprocating steam pump is seen about midway between the second and third drivers. This illustration also shows the Walschaerts gear.

Each engine has an injector of the Hancok type for supplementary feed. The main throttle valve fitted to all the engines is of the Bradford front-end type, arranged between the superheater and steam chests, and outside connected to the driver's lever in the cab. Placing the throttle in this position makes superheater steam available for auxiliaries, including the tender truck booster engine, but excluding the whistle and blower.

A constructional feature of particular interest is the one-piece locomotive bed frame of cast steel. These frames, two views of which are reproduced, comprise in a single unit the main side framing, the cylinders with valve chests and smokebox saddle, and the cradle for the firebox support, also all brackets and the air brake reservoirs, the latter being arranged in the centre, where they add considerable strength and stiffness to the whole frame structure. A notable detail in these castings is the inclusion of the back heads of the cylinders. One of the views shows this construction, also the slidebar support, and the facing for the valve motion bracket casting. These frames were made by the General Steel Castings Corporation.

The trial engine, No. 5200, built by the American Locomotive Company, had crossheads of the Laird pattern, while the Baldwin and all the 20 new engines have the Pennsylvania type, having multiple bearings surfaces. The main connecting rods and the coupling rods are of carbon-vanadium steel, fitted with floating bushings for the main pins, and the main connections for the coupling rods are similarly equipped. For the remaining pins solid bushes are used. The cylinders and piston valve bushes are of Hunt Spiller iron, and all the engines have 12-inch valves operated by the Baker motion controlled by the Franklin power reversing gear. In full gear the

Fig. 2. — 4-8-4 locomotive No. 5100, showing Elesco feed water heater, Baldwin Locomotive Works.

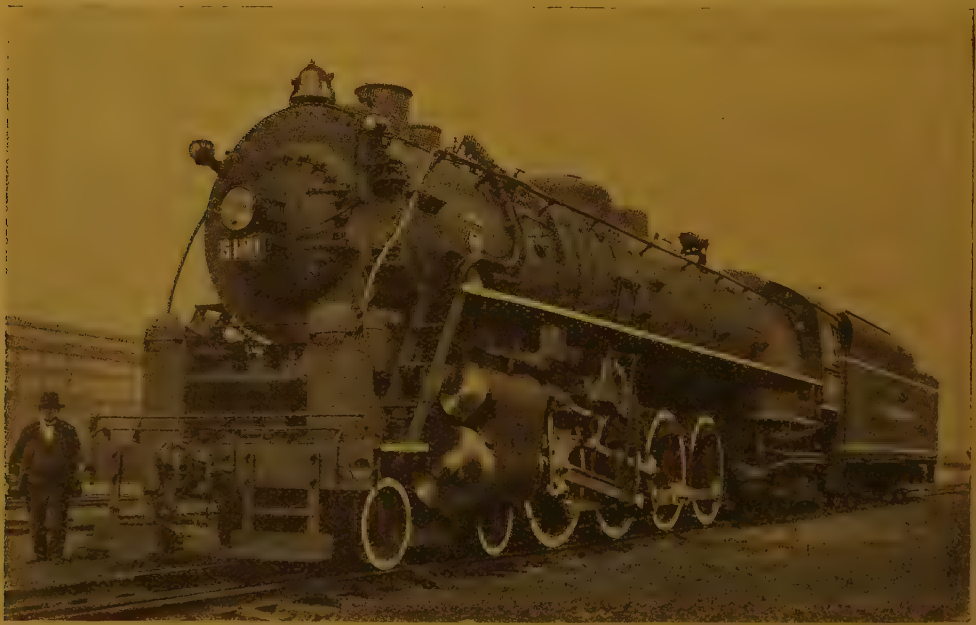


Fig. 3. — 4-8-4 locomotive No. 5001, Baldwin Locomotive Works.

valve travel is 8 5/8 inches and the valves have a steam lap of 1 5/8 inches, exhaust clearance of 3/16 inch and 1/4 inch lead.

The coupled wheels are spaced 6 ft. 5 in. between centres, and thus the engines have an equal wheelbase for the coupled axles of 19 ft. 3 in., but as the leading axles are fitted with Franklin lateral motion boxes, the rigid wheel base is 12 ft. 10 in. The journal bearings are 11 inches by 14 inches except for the main, which are 13 inches by 14 inches. Timkin roller bearings are used for the leading trucks, and, for the trailing four-wheeled trucks, plain bearings, 8 inches by 14 inches for the Baldwin, and 7 inches by 14 inches and 9 inches by 14 inches for the American, the larger being for the trailing axle. For both engines the leading and trailing trucks are by the General Steel Castings Company, the latter being of the Delta type. The leading trucks have 33-inch rolled steel wheels, and the trailers have wheels with cast steel centres and separate tyres, the Baldwin engines having equal sized wheels, 33 inches diameter, and the American unequal wheels, 36 inches for the leading pair and 45 inches diameter for the trailers.

The total wheelbase is, for the Baldwin 44 ft. 11 in., and for the American engines 45 ft. 7 in. The Baldwin design carries 270 000 lb. (120.5 tons) on the drivers, giving an adhesive factor of 4.06, and the American with 269 000 lb. (119.8 tons) has a factor of 4.03. The springs are all placed over the axleboxes, as is usual in U. S. practice, and com-

Fig. 4. — Cast-steel locomotive frame, side elevation.

pensation is continuous from the leading coupled axle to the trailing truck. A 16-feed forced-feed mechanical lubricator supplies oil to the cylinders, valves, crosshead slides, air pumps, driving and trailing wheels hubs, and the auxiliary locomotive on the tender. Alemite grease fittings are applied to the motion, the spring gear and brake rigging, and also to the tender brake hanger pins.

Tenders.

The first two engines had, as already stated, 18 000-gallon tenders, and though trials have shown that this capacity together with the condensate recovered from the feed heating equipment, was normally sufficient, the 20 new locomotives have larger tenders carrying rather more coal, 60 000 lb., or 27 tons, as against 56 000 lb., or 25 tons, and with the larger tank capacity of 20 000 gallons,

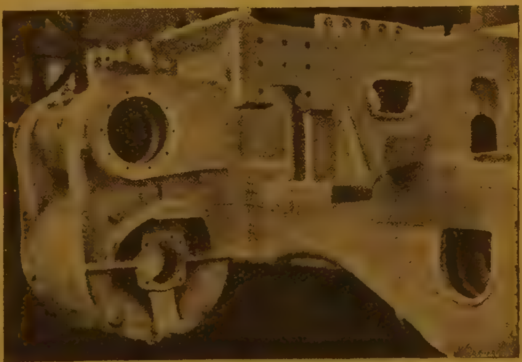


Fig. 5. — Integral cylinder hind covers on cast-steel frame.

comparing with 18 000 before. These tenders run on 12 wheels, 36 inches diameter. The front truck is of cast steel, and the axles have ordinary journal bearings 6 1/2 inches, by 12 inches, the hind truck comprising the Bethlehem auxiliary locomotive, with six coupled wheels, has S.K.F. roller bearings. It should here be mentioned that the original locomotives had the same booster arrangement, but with four-wheel drive only. These tenders have cast steel underframes of the water bottom type, which have been made by the General Steel Castings Corporation. The total tender wheel base in 36 ft. 6 1/2 in. and the distance between the truck centres is 26 ft. 1 in. The Baldwin tenders have a light weight of 174 000 lb., or 77.7 tons, and the American weigh 164 700 lb., or 73.5 Engl. tons, and the loaded weights are 398 000 lb. (177.9 Engl. tons) and 389 100 lb. (173.3 Engl. tons) respectively. The Westinghouse air brake acts on the coupled wheels and also on the tenders.

The Lehigh Valley main line.

The trials carried out with the two locomotives were made on the main line between Buffalo and Newark (Oak Island), and before giving the results obtained it will be convenient to describe briefly the principal characteristics of the road.

The more important tests were made on eastbound trips from Buffalo, and travelling in this direction the various divisions in their order are as follows. The letters refer to table II, which sets out the more important data obtained on through journeys from Tifft Terminal, N. Y., to Oak Island (Newark, N. J.).

Division.	*Miles.*
A. — Tifft Terminal, N. Y., to Manchester, N. Y.	94.3
B. — Manchester, N. Y., to Sayre, Pa.	88.7
C. — Sayre, Pa., to Coxton, Pa. . . .	84.6
D. — Coxton, Pa., to Mahoming, Pa. .	62.5
E. — Mahoming to Oak Island (Newark, N. J.)	108.9

The division from Tifft Terminal to Manchester has no important grades, though the line rises generally for the first 23 miles at almost 20 feet to the mile, or 1 in 270. There are then about 20 miles of undulating road on similar gradients followed by a drop for 14 miles again at 1 in 270, and the rest of the run to Manchester is almost level. The line between Manchester and Sayre, both eastbound and westbound, has heavy grade sections, and it is on this portion of the road that most of the trials were made, giving opportunity to work the engines at capacity over long periods. Further, this part of the line is an important section on through runs, it being desired to operate fast trains unassisted on the heavy grades. Starting from Manchester, the line generally falls to Geneva Junction, 17 3/4 miles, and from thence to Himman there are 42 miles of rising grades varying from 12 to 21 feet per mile, 1 in 440 to 1 in 250, the average grade for the entire distance being approximately 1 in 328. From the summit the line falls all the way to Sayre, the gradient varying between 10 to 21 feet per mile, or 1 in 528 to 1 in 250. The road between Sayre and Coxton is an easy division, the line, in fact, falling on the average very slightly over the entire distance. From Coxton to Hahoming includes a heavy pull for the first 21 miles up to Gracedale, the grade being at the rate of 61.5 feet per mile for nearly 13 miles, or 1 in 86. After passing Gracedale the road again falls for the rest of the run to Mahoming, and then on to Newark, N.J., the line is almost level, except between Phillipsburg and Lansdown, N.J., there is a rising grade to the tunnel of about 22 feet per mile for 15 miles, then descending to Lansdown 8 miles on an average grade of 42 feet per mile throughout. Over the grade between Coxton and Gracedale an assistant engine is provided.

Engine trials.

Tests carried out with the two new locomotives Nos. 5100 and 5200 were

conducted for two main purposes. One object was to find and compare the performance characteristic of the engines, and the other to determine the advantage, if any, of using locomotives of this type compared with those in operation, and, in addition, full particulars of the performance of the engines was desired both operating and mechanical. These two locomotives were built to operate in a certain traffic, and to comply with a definite schedule, and handle trains of a given tonnage, and the principal information wanted was to determine their ability to meet the conditions imposed, and the consumptions of fuel and water necessary in relation to the developed power.

The various trial runs were made between the beginning of May and the end of July, 1931. All the trials were made under ordinary working conditions; when the locomotives were hauling ordinary trains, special enginemen were not employed. The division between Sayre and Manchester was used for all runs made for comparative purposes, because it was possible to obtain satisfactory trains and schedules, and further it was considered that the long grades going both east and west made it particularly well adapted for testing. One through trip from Tifft Terminal to Oak Island, Newark N. J., was made with each locomotive for record purposes. Actually the most complete records of performances were made on the eastbound runs from Manchester to Sayre, and of these the trips over the 42 miles of rising grades extending from Geneva Junction to Himman were those upon which most of the comparative data was based.

When estimating the amount of water from the tender to the engine, as no arrangements were made to measure the actual condensate returned to the tender by the feed water heater, 12 % of the water measured as being taken from the tank was added to allow for that recovered in the form of condensate.

Injector losses were assumed after noting the times they were in operation. Losses due to the safety valves were assumed as being 100 lb. per minute while the valves were lifted. The steam consumption of the auxiliaries was assumed to be 25 lb. per minute of time while the engines were working. This computation is considered as being low, but as it was used for all tests with each engine the results are comparative. Water gauge level readings were recorded in the engine cab, and if the boiler had more water in it at the end of the test than at the commencement, this amount was subtracted when estimating the steam to the engines, and added if the gauge showed less water at the end than at the beginning. The degree of superheat in the steam was determined by subtracting the temperature of the steam at boiler pressure from the steam temperature in the branch pipe. The steam delivered to the cylinders per hour is the total water from the tender, less that used by the injectors, pops, and auxiliaries, plus or minus the boiler correction divided by the working time, that is, the time steam was « on ». Train weights are given in U.S. tons of 2 000 lb.

Test results.

The working results obtained during the trials with both these large locomotives are given by the tabulated statements numbers II to V inclusive. The coal used for all tests was that ordinarily used on the various divisions, and samples were taken from all loadings. A typical analysis is as under; the values are about the mean for 12 different samples :

Moisture	1.70 %
Volatile matter	34.16 »
Fixed carbon	53.66 »
Ash	10.48 »
Sulphur	5.16 »
B. T. U.	12 830

The data given in the accompanying tabulated statements has been abstracted from the official report on these trials, and Table II has been prepared to show

Table II. — THROUGH TRIP: TIFFT TERMINAL (BUFFALO) TO OAK ISLAND (NEWARK, N. J.).

Divisions.	Buffalo to Manchester.		Manchester to Sayre.				Sayre to Coxton.		Coxton to Mahoming.		Mahoming to Oak Island.	
			Complete Trip.		M.P. 342 to 300.							
Run number	136A	148A	136B	148B	136B	148B	5200	148C	136D	148D	136E	148E
Engine number	5200	5100	5200	5100	5200	5100	136C	5100	5200	5100	5200	5100
Schedule time . . minutes.	180	180	165	165	—	—	165	165	190	195	180	240
Number of stops	3	4	1	0	1	0	0	1	2	3	1	2
Net running time . minutes.	179.3	171.7	150.75	142.9	80.3	79.1	112.7	129.2	166.3	174.4	185.45	167.25
Working time . . minutes.	168.5	156.3	134.8	135.5	78.7	79.6	111.0	114.6	118.4	135.3	137.6	120.2
Working distance . miles.	88.48	81.93	78.14	80.52	41.31	42.0	82.54	74.91	35.81	38.88	78.56	76.0
Average working speed . . . . . m.p.h.	31.5	31.5	34.7	35.6	31.5	31.6	44.6	39.2	18.15	17.13	33.0	37.8
Weight of train . . . tons.	3.118	3 219	2 878	3 093	2 878	3 093	2 878	3 018	3 213	3 018	3 069	3 138
Total number of cars	77	71	73	75	73	75	73	72	83	72	78	75
Car-miles	7 084	6 361	6 351	6 525	3 066	3 150	6 059	5 931	4 992	4 331	8 213	7 897
Rail conditions	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Temp. — Crane water . ° F.	65	62	68	82	68	82	58	73	70	80	64	78
Temp. — Steam branch pipe . . . . ° F.	638	595	661.2	649	665	663.5	609	630	622	630	635	654
Superheat branch pipe . ° F.	237	195.4	260	251	265	251	207.2	—	222	230.4	233	255.5
Boiler pressure, engine	247	239	245	239.3	245	241.8	247.1	241.4	246	239	243	240
Boiler pressure, dynamo. car.	247	242	248	242.4	250	242.9	249.5	—	248.6	245	254.2	245.7
Steam chest pressure, dynamo. car	234	231	234.5	227.6	236.5	227.2	238	—	232.5	231	238.5	228
Total coal fired . . . lb.	20 520	18 445	19 575	21 070	11 775	13 885	11 245	14 215	14 250	16 675	16 875	17 645
Coal fired per hour	7 231	7 094	8 700	9 323	8 985	10 440	6 078	7 442	7 234	7 411	7 369	8 822.5
Coal fired per hour, sq. ft. of grate per hour . . . lb.	81.5	80.33	98.5	105.58	101.8	118.23	68.8	84.3	81.9	83.9	83.5	100.0
Water from tender inc. condensate	154 560	132 770	139 720	132 496	78 120	83 664	80 192	98 000	97 216	106 288	125 216	128 688
Water to boiler . . . lb.	154 500	132 700	139 700	132 450	78 100	83 650	80 150	97 950	97 150	106 250	125 160	128 600
Steam to cylinders . . . lb. per hour.	52 647	48 264	60 535	57 373	58 116	61 345	42 590	49 277	47 051	45 529	53 268	62 552
Superheated steam per lb. of coal	7.28	6.8	6.96	6.15	6.47	5.88	7.01	6.64	6.5	6.14	7.23	7.09
Total water per lb. of coal	7.52	7.19	7.14	6.32	6.64	6.25	7.27	6.83	6.82	6.37	7.46	7.28
Drawbar H.P., average	2 406	2 097.3	2 839	2 593.7	2 994	2 964.2	2 259	2 240	1 508	1 467	2 163	2 595
Drawbar pull, average	28 538	25 006.7	30 608	27 275	35 643	35 112	18 983	21 420	31 153	31 914	23 673	25 654
Coal per D.B.-H.P.-hour	3.0	3.38	3.06	3.59	3.00	3.52	2.69	3.32	4.80	5.05	3.41	3.4
Superheated steam per D.B.-H. P.-hour	21.88	23.01	21.32	22.12	19.41	20.7	18.85	22.0	31.20	31.03	24.63	24.10
Water reg'd by loco. per D.B.-H.P.-hour	22.5	23.72	21.84	22.56	19.91	21.96	19.51	22.62	32.19	32.06	25.33	25.33

the principal results obtained on a through run from Tifft Terminal to Oak Island (Newark, N.J.). The schedule time allowed for each run over the particular division is given, and the net running time is that taken after deducting the time occupied by stops. The working speed in m.p.h. is based on the working distance and time.

The hourly coal consumption is equal to the total coal fired over each division, divided by the working time, and this figure divided by the grate area of 88.3 sq. feet for each engine gives the rate of firing. With these explanations the particulars given are sufficient to enable the performance of the two locomotives to be compared. Table III gives the mean

TABLE III. — COMPARISON OF AVERAGES.
Manchester to Sayre......Eastbound.

Engine:	5200		5100	
	Complete.	M.P. 342 to 300.	Complete.	M.P. 342 to 300.
Tonnage	3 011	3 011	3 097	3 097
Number of cars	77	77	66	66
Train sheet time	153	—	151	—
Working time	131.2	73.7	128.5	75.2
Average back pressure	—	4.33	—	14.12
Average draft	—	11.60	—	10.13
Total coal	20 888	12 666	19 941	12 841
Coal per sq. foot or grate per hour	108.2	117	105.4	116
Coal per D.B.-H.P.-hour	3.26	3.16	3.43	3.31
D.B.-H.P.	2 929	3 043	2 724	3 115
D.B. pull . . . lb.	30 230	35 899	27 994	35 085
D.B.-H.P.-hours	6 412	4 009	5 836	3 899
Total water	139 562	79 965	133 175	80 145
Steam to cylinders per hour	61 229	63 313	60 908	62 894
Water per lb. of coal	6.71	6.32	6.73	6.36
Water per D.B.-H.P.-hour	21.79	19.92	22.90	20.89
Mechanical efficiency, per cent	—	91.72	—	89.8
Engine friction . . . lb.	—	3 451	—	4 093
Distance over Division, miles	88.7	42	88.7	42
Speed, miles per hour	34.8	34.2	35.2	33.5

results obtained with each locomotive, based on four trips over the Buffalo Division eastbound.

The average performance is shown by the complete division and also for the 42 miles of rising grades between the mile posts 342 and 300, that is, from Geneva Junction to the summit at Himman. In connection with the data for the latter it will be noted that the mechanical efficiency is shown. The mechanical efficiency of each engine was determined by indicator diagrams taken at various points on the uphill 42-mile grade, and in selecting diagrams for this purpose it was first determined whether each card, both left- and right-hand sides, was taken correctly. The dynamometer chart was then examined to see if the speed and pull were uniform at the time the cards were obtained in order to eliminate as far as possible errors due to acceleration or deceleration, and variation in grade. Diagrams meeting these requirements were then computed for horsepower, and the pull and

TABLE IV. — COMPARISON OF BOILER AND ENGINE PERFORMANCE.

Manchester to Sayre. On hill, M. P. 342 to M. P. 300.

Engine No.	5200	5100
Trip No.	131	143
Average working speed	33.3	33.1
D.B.-P.H.-hours	4 237	4 208
D.B.-H.P., average	3 363	3 313
Coal fired per hour	10 730	10 531
Coal fired per sq. foot of grate per hour	121.5	119.3
Water from tender, including condensate	83 888	86 486
Water to boiler	83 860	86 450
Steam to cylinders, per hour	65 060	67 512
Temperature of crane water	72	76
Boiler pressure: engine	249	245.6
— — dynamo. car	252.3	250.0
Steam chest pressure: dynamo. car	236.4	233.0
Drop in pressure	15.9	17.0
Steam temperature, branch pipe	674.2	677.7
Superheated steam per lb. of coal	6.06	6.41
Total water per lb. of coal	6.20	6.55
Superheated steam per sq. foot of total heating surface	8.47	8.81
Coal per D.B.-H.P.-hour	3.19	3.18
Water per D.B.-H.P.-hour	19.34	20.38
Water required by locomotive per D.B.-H.P.-hour	19.79	20.82

speed gave the power on the drawbar, which when corrected for grade and curvature enabled the mechanical efficiency to be calculated. The mean values given in the table are obtained from a number of observations taken at the same point for both engines. As the efficiency expressed per cent, is dependent upon the rate of working, the locomotive friction obtained at the same time expressed in pounds is also given as being a better gauge of performance. The steam required per I.H.P.-hour can be seen by computing the cylinder power from the mechanical efficiency. The water rate per I.H.P.-hour being, for engine No. 5200, 18.55 lb., and for 5100, 18.23 lb., based on the water estimated as being supplied to the cylinders, and, of course, like the other data, are the mean consumptions covering four eastbound trips over the 42-mile grade.

The next table, IV, has been compiled to show the relative performance of the boilers and cylinders when the work output for both locomotives as shown by the respective horsepower-hours was as near as possible equal. The superheated steam in pounds per hour is compared with the total combined heating surface. The superheated steam per sq. foot of combined heating surface is 7.45 and 7.67 lb. for engines 5200 and 5100 respectively. The total water from the tenders is 83 888 and 86 486 lb., and as the working time in minutes is 75.4 and 76.4 respectively, the water per hour is 66 750 and 67 926 lb., and the actual water delivered to the boilers is 66 732 and 67 890 lb. per hour. The difference between these figures represents losses at the injectors.

The coal rate is equal to the total coal fired per hour divided by the mean drawbar horsepower, and the water consumption is based on the quantity charged to the cylinders, or actually used to develop the power, and also on the basis of the total water per hour taken from the tender required by the locomotive.

Table V. — TIME — SUMMARY OF PERFORMANCE. Tifft Terminal (Buffalo) to Oak Island (Newark, N. J.).

Engine.	Run.	Division.	Miles.	Number of cars.	Tons.	Schedule time, minutes.	Time train sheet.	Mins. dyn. car.	Stops, number.	Running time, minutes nett.	Speed m. p. h.
5200	136A	Tifft terminal to Manchester	94.3	77	3 118	180	210	216.1	3	179.3	31.4
5100	148A			71	3 219	180	216	215.5	4	171.7	32.9
5200	136B	Manchester to Sayre	88.7	73	2 878	165	153	151.6	1	150.75	35.2
5100	148B			75	3 093	165	145	142.9	0	142.9	37.2
5200	136C	Sayre to Coxton	84.6	73	2 878	165	114	112.7	0	112.7	44.8
5100	148C			72	3 018	165	135	138.2	1	129.2	39.2
5200	136D	Coxton to Mahoming	62.5	83	3 213	190	224	227.5	2	166.3	22.5
5100	148D			72	3 018	195	183	191.1	3	174.4	21.5
5200	136E	Mahoming to Newark	108.9	78	3 069	180	184	186.7	1	185.45	35.2
5100	148E			75	3 138	240	169	170.25	2	167.25	39.0

Note. — The nett running time is equal to the dynamometer car time, less the time consumed by stops. The speed is based on the nett running time. An assistant engine is used on the heavy grade extending for the first 21 miles from Coxton to Mahoming, maximum grade 61.5 ft. per mile.

A summary of the running between Tifft Terminal and Oak Island yards is given by table V. This shows the schedule and net running times over each division, with the train loads and actual average speeds attained, based on the time in motion. Accepting car-miles per hour as a basis of performance, the work done over each division is very closely equal, except for the heavy grade section between Coxton and Mahoming, when an assistant engine is used over the 21 miles from Coxton up to Gracedale.

The maximum powers developed by these engines during the different tests were as follows :

Engine 5200: I. H. P. 4 101.2 at 33 m. p. h., the corrected D. B. H. P. being 3 864.9, giving a mechanical efficiency of 94.2.

Engine 5100: I. H. P. 4 050.1 at 35 m. p. h., when the corrected D. B. H. P. was 3 693.8 and the mechanical efficiency therefore 91.2 per cent.

General conclusions.

Judging by the data obtained, the two engines are almost identical in all items of performance. There are, as will have been noted, a few slight differences, but having regard to the fact that all observations were made under normal operating conditions, it is thought the differences are so small as to come within the range of errors in making the several different observations necessary when compiling all the data required for such comprehensive tests. From a mechanical point of view both engines were considered satisfactory, especially as to the machine efficiencies and boiler performance, and in respect to the former it is suggested that the integral cast steel framing might have a bearing on this feature. It was noted that both engines ran well at high speeds, and that their riding qualities were excellent.

The writer wishes to acknowledge considerable assistance received from Mr. W. I. Cantley, Mechanical Engineer, Lehigh Valley Railroad, in the preparation of these articles, and for some of the photographs reproduced, and also for placing at his disposal the results of the most complete tests which have been carried out with both locomotives.

In addition the writer is indebted to the Baldwin Locomotive Works for the photographs used for figures 2 and 3; the latter, it may be pointed out, clearly shows the rotary type of cold water pump at the hind end, and at the front, above the left-hand cylinder, the reciprocating hot feed pump for the Worthington type-S feed heater equipment.

[621. 132.3 (44)]

The altered " Pacific ,, type locomotive No. 231-F-141 of the Paris, Lyons & Mediterranean Railway,

by E. SPIESS.

(*Les Chemins de fer et les Tramways*).

The aim today, for working express trains, is to have more powerful locomotives able to run greater distances. The Paris-Lyons & Mediterranean Railway Company has taken steps to meet the position by modifying its existing engines step by step in accordance with a definite programme, instead of building new engines. This method has the advantage that the alterations can be tried out and the altered engines compared with the original design before being finally adopted for general use. This point must be remembered when considering the performance of the 231-F-141 *Pacific* locomotive, which is

an old *Pacific* of the 231 D class, built in 1923, and recently altered in the following respects :

Boiler pressure increased from 16 to 20 kgr./cm² (227 to 284 lb. per sq. inch);

New P. L. M. type double blast pipe and chimney;

New cylinders with larger steam passages;

A superheater header with separate steam chambers; and

A Dabeg economiser with elements in the flue tubes.

The results obtained with the altered engine are most interesting. A train of 430 t. (423 Engl. tons) has been worked between Paris and Lyons (511 km. = 317 miles) at the overall speed of 100 km. (62 miles) an hour with a definitely lower fuel consumption, while the fire was maintained in perfect condition. A brief description of this engine is given

below, the improvements being especially noted, with the officially recorded results of the trials.

The locomotive, originally built in 1923, was rebuilt by the Company at its own Oullins shops. The leading dimensions of the altered engine are as follows:

4-cylinder compound *Pacific* type locomotive.

Total length over buffers	13.990 m. (*45 ft. 11 in.*)	
Maximum width	3 m. (*9 ft. 10 1/8 in.*)	
Height over chimney	4.280 m. (*14 ft. 1/2 in.*)	
Total wheel base	11.230 m. (*36 ft. 10 1/8 in.*)	
Rigid wheel base	4.200 m. (*13 ft. 9 3/8 in.*)	
Leading bogie wheel base	2.300 m. (*7 ft. 6 9/16 in.*)	
Firebox:		
Inside length (at the bottom)	2.079 m. (*6 ft. 9 7/8 in.*)	
Inside width	1.922 m. (*6 ft. 3 11/16 in.*)	
Grate area	4.25 m² (*45.7 sq. ft.*)	
Boiler:		
Pressure	20 kgr./cm² (*284 lb. per sq. inch*)	
Inside diameter, large ring	1 718 m. (*5 ft. 7 5/8 in.*)	
Distance between tube plates	6 m. (*19 ft. 8 1/4 in.*)	
Height of boiler centre line	2.900 m. (*9 ft. 6 3/16 in.*)	
26 flue tubes	141/150 mm. (*5.55 in./5.90 in. diam.*)	
124 smobe tubes	51/55 mm. (*2.00 in./2.165 in. diam.*)	
26 superheater elements.		
22 economiser elements.		
Heating surface:		
Firebox	15.68 m² (*168.8 sq. ft.*)	
Tubes	188.14 m² (*2 025.0 sq. ft.*)	
Total	203.82 m² (*2 193.8 sq. ft.*)	
Superheating surface	44.58 m² (*479.9 sq. ft.*)	
Total combined surface	248.40 m² (*2 673.7 sq. ft.*)	
4 cylinders	2 high pressure.	2 low pressure.
Diameter	400 mm. (*15 3/4 in.*)	650 mm. (*25 5/8 in.*)
Stroke	650 mm. (*25 5/8 in.*)	650 mm. (*25 5/8 in.*)
P. L. M. conjugated Walschaerts valve gear.		
Piston valves	High pressure.	Low pressure.
Maximum stroke	172 mm. (*6.77 in.*)	221.5 m. (*8.72 in.*)
Diameter	240 mm. (*9.45 in.*)	360 mm. (*14.17 in.*)
Wheel diameter:		
Coupled	2 m. (*6 ft. 6 3/4 in.*)	
Bogie	1 m. (*3 ft. 3 3/8 in.*)	
Bissel truck	1.36 m (*4 ft. 5 9/16 in.*)	
Weight in working order:		
Adhesive weight	57 t. (*56.1 Engl. tons*)	
Total weight	100.15 t. (98.55 *Engl. tons*).	
Tractive effort at starting (1)	10 087 kgr. (*22 237 lb.*)	

(1) The tractive effort is calculated by the formula:

$$F = \left(\frac{0.65 \times P \times d^2 \times l}{D}\right) + \left(\frac{0.65 \times P' \times d'^2 \times l}{D}\right)$$

P and *d* relating to the high-pressure cylinders;
P' and *d'* to the low-pressure.

$$\text{Whence } F = \frac{0.65 \times 14 \times 40^2 \times 650}{2000} + \frac{0.65 \times 6 \times 65^2 \times 650}{2000} = 4\,742 + 5\,355 = 10\,087 \text{ kgr.}$$

Boiler.

The only alterations made were those necessitated through increasing the pressure from 16 to 20 kgr. (227 to 284 lb. per sq. inch), fitting the improved blast pipe and rearranging the flues and tubes.

Firebox. — The firebox is the same as that of the 231 D and F engines with 16 kgr./cm² pressure. The only change has been to strengthen the firebox roof stays by increasing their diameter from 19.5 to 24 mm. (0.77 to 0.945 inch), while those on the radius of the firebox crown have been made 26 mm. (1.024 inch). The copper side and tube plates are 14 mm. (0.55 inch) thick.

Barrel. — The boiler pressure is 20 kgr./cm² (284 lb. per sq. inch). The volume of the boiler is 11.290 m³ (398.7 cu. feet), the water volume being 7.290 m³ (257.4 cu. feet) and the normal water level being 114 mm. (4 15/32 inches) above the firebox, the engine being on the level.

The thickness of the barrel plates has been increased from 19 to 23 mm. (0.748 to 0.905 inch); the staying of the smoke box tube plate which is 20 mm. (0.787 inch) thick has been reinforced.

The tubes are arranged differently from those of the old 16 kgr./cm² locomotive, the object of the change being to improve the superheat by improving the passage ways for the combustion gases through the flue tubes as shown in the table below :

	227-lb. pressure locom.	284-lb. pressure locom.
Tubes :		
Smoke tubes	128 of 51/55 (*2.0/2.165 in. ⌀*)	124 of 51/55 (*2.0/2.165 in. ⌀*)
Flue tubes.	26 of 135/143 (*5.31/5.63 in. ⌀*)	26 of 141/150 (*5.51/5.90 in. ⌀*)
Superheater :	26 elements of 28/35 (*1.1/1.38 in. ⌀*) Combined header.	26 elements of 28/35 (*1.1/1.38 in. ⌀*) Separate chamber header.
Area of gas passages :		
Through the smoke tubes. S_b	0.2615 m² (*405 sq. in.*)	0.2533 m² (*392.6 sq. in.*)
Through the flue tubes S_s	0.2721 m² (*421.7 sq. in.*)	0.3059 m² (*474 sq. in.*)
Ratio $\frac{S_s}{S_b}$	1.04	1.21

When considering the value of the ratio

$$\frac{\text{Sf (superheating surface)}}{\text{S (total heating surface)}},$$

in this case 1 to 4.56, we have to remember that the improved blast not only gets rid of the combustion gases better, but also ensures a better heat exchange in the tubes.

Smoke box. — The interior fittings of the smoke box have been rearranged to enable the new P. L. M. type double blast pipe with its two chimneys to be fitted as well as the Dabeg economiser and the new superheater headers of which we will speak later on. The distances between the centre line of the double chimney to the front tube plate and to the door joint are 1.620 and 0.880 m. (5 ft. 3 25/32 in. and 2 ft. 10 5/8 in.) respectively. The different fittings in the smoke box in front of the tubes have been arranged to reduce the resistance to the draught to a minimum, the blast

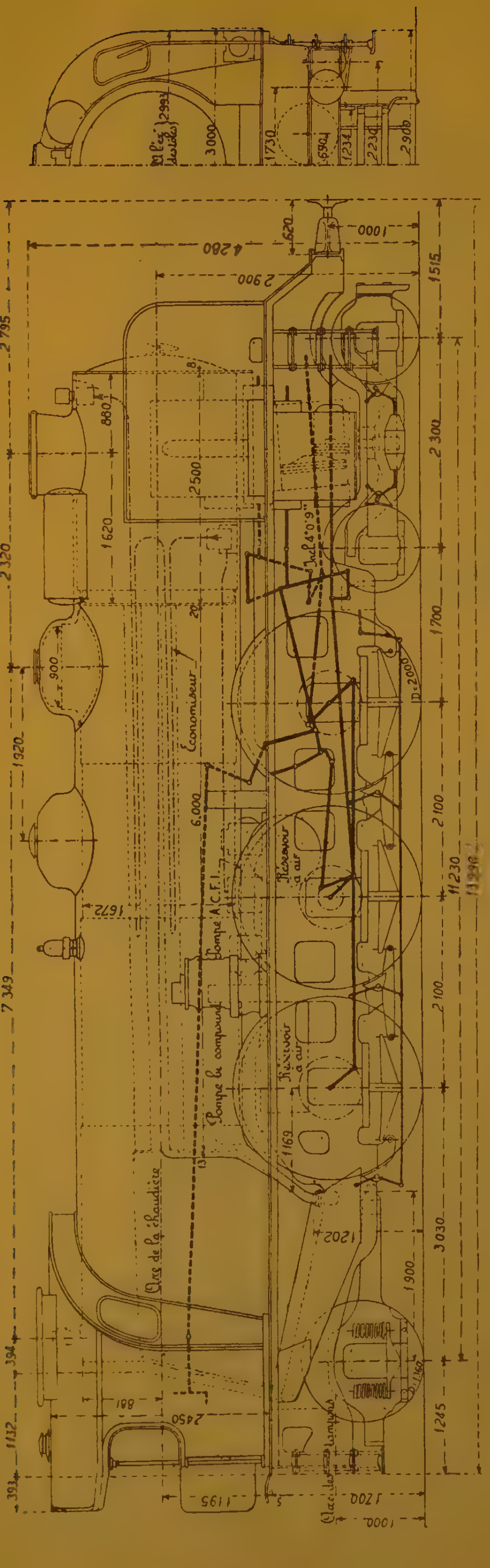


Fig. 1. — General arrangement of locomotive No. 231-F-141.

Explanation of French terms:

A l'ext' des tôles = Outside plates. — Axe de la chaudière = Boiler centre line. — Axe des tampons = Buffer centres. — Economiseur = Economiser. — Pompe ACFI = ACFI pump. — Pompe bi-compound = Two-stage compound pump.

being helped when the engine is running by the action of the side screens and by the new blast pipe.

Superheater. — The superheater, made by the Superheater Company, has separate saturated and superheated steam collectors (figs. 2 and 3). There are 26 elements of 28 × 35 mm. (1.1/1.38 in.) as mentioned above. These elements are fastened to their header by forged spherical joints. The loops of these elements are in the back half of the flues. The two return bends are taken as near the firebox tube plate as possible. The geatest heat exchange thus takes place in the loops, especially at the bends, and the superheating is therefore done in the hottest part of the nest of tubes, whereas in the straight part of the return tube, i. e. in the front half of the tubes, there is practically no heat exchange between the superheated steam, now slightly hotter than the combustion gases but moving in the same direction, and these gases. In addition, by using a header with separate chambers, any loss through the wall between the saturated and the superheated steam chambers is avoided. An increase in superheat of about 15 to 20 % has been obtained in this way.

Feed water heating. — The feed water is drawn from the tender by an ACFI feed heater pump and sent to a Dabeg flue tube economiser. This economiser receives the feed water at a temperature varying from 98-100° C. (208.4 to 212° F.) and raises it to 135-140° C. (275 to 284° F.). It consists of 22 elements of the same design as the superheater elements, fitted inside the large flue tubes in front of the front bend of the superheater elements; they extend 3.635 m. (11 ft. 11 in.) only inside the flues. As they occupy space which otherwise would be taken up by the return bends of the superheater elements, additional resistance to the combustion gases is not produced . Moreover there is no great loss

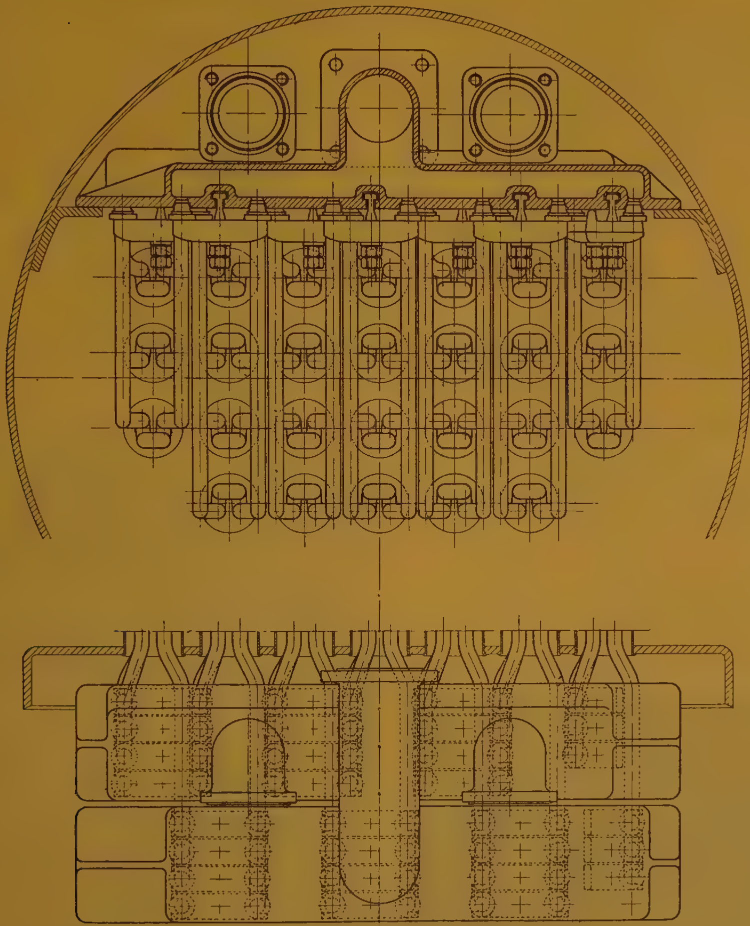


Fig. 2. — Superheater Company's separate-chamber superheater header (elevation and plan showing general arrangement).

of superheat (as observed when the return loop was partly in the smoke box). The combustion gases while being useless from a superheating point of view in the front half of the nest of tubes are hot enough to heat up the boiler feed water efficiently.

The various elements of the economiser have been profiled and their connections thinned down and curved so as to reduce the resistance to draught to a minimum.

The Dabeg smoke box economiser, starting from the ACFI pump, includes the following parts :

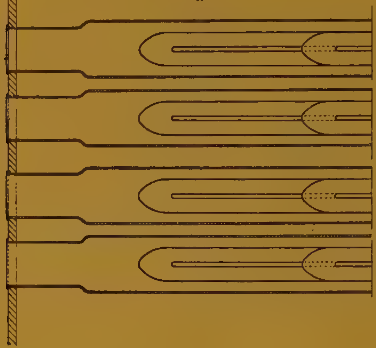
A non-return valve;

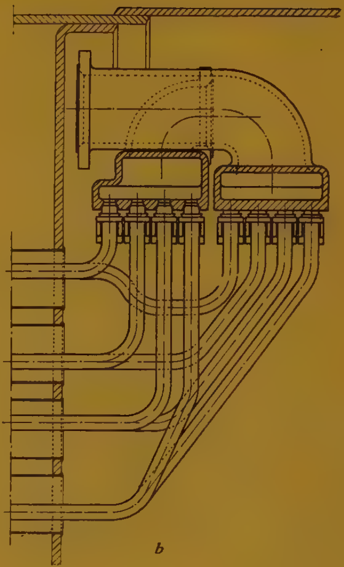
A bottom or inlet water header;

Fig. 3. — Separate-chamber superheater header.

a) Part section showing the position of the superheater return bends at the firebox end;

b) Part section showing the separate superheater and saturated-steam headers with spherical joints (same scale as fig. 2).





The heating elements properly speaking of the economiser;

An upper or discharge water header.

Fig. 4. — Front view of Dabeg economiser.

The bottom header is placed at the bottom of the tube plate (fig. 4). It has 6 outlets, each feeding 3 or 4 heater elements arranged in series in the flues. The upper header is fitted in the smoke box in front of the chimney (fig. 5).

The different elements can de blown down, when the engine is running, through a drain pipe fitted with blow down valves and drain cocks; this arrangement is also used when the boiler is being washed out by means of a weak acid solution circuit in the shops.

In accordance with the regulations, the locomotive is also fitted with a second feed device, in this case a live steam injector.

P.L.M. type double blast pipe. — The double blast pipe and chimney is one of the most important changes made to the engine. With this new blast pipe, known as the P.L.M. type double blast pipe with crossed bridges, the fuel burnt per sq. foot of grate can be increased with a lower exhaust back pressure. This blast pipe was invented by

Mr. Parmantier, Assistant Chief Mechanical Engineer of the Company, the experimental work being done by the Company. The differences between this blast pipe and the old P.L.M. variable clover type (Cf. figs. 5 and 6) are as follows :

1. Two separate chimneys, of the same dimensions;

2. Large passages for the exhaust steam and combustion gases;

3. Two crossed adjustable bridges giving four separate jets, the sections of which can be altered;

Fig. 5. — Front view of new P. L. M. type double blast pipe (the top header of the economiser can be seen in front at the top)

4. A petticoat pipe to equalise the draught over the grate.

In addition, when comparing these two patterns of blast pipe (fig. 6), it will be noticed that the passages in the new design are free from eddying and sudden changes in section, unavoidable with the old arrangement; the result has been to reduce the loss of pressure to a minimum and the blast can be set more efficiently.

The practical result of fitting the engine up in this way has been that the rate of firing can be definitely increased, while the fire remains in good order with much less clinkering and less grate maintenance.

The exhaust back pressure has been reduced at least 50 %.

Many adjustments and trials had to be made before the best results were obtained with the new double blast pipe. The *Mountain* type locomotives have been fitted up in the same way.

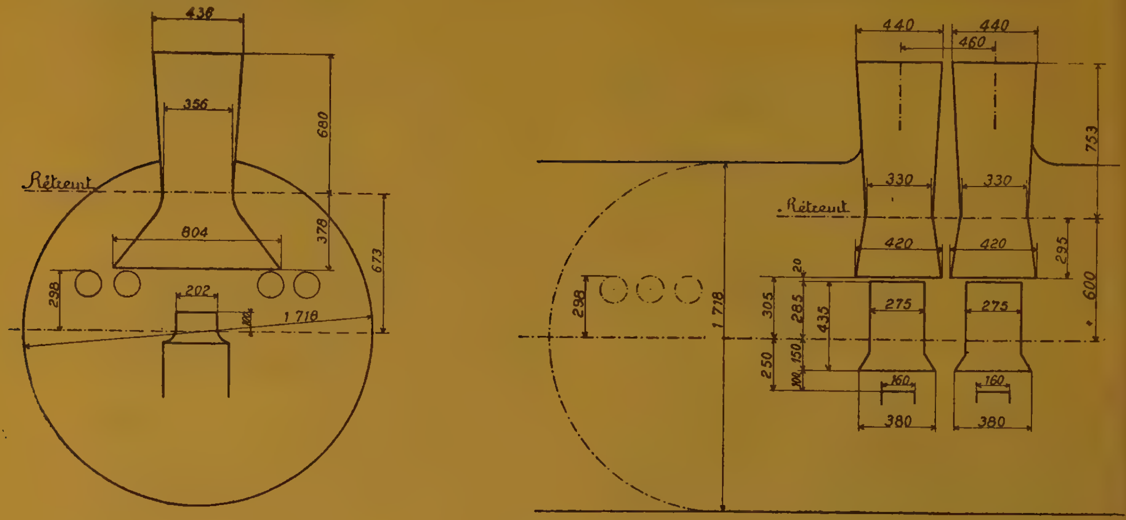
Motion and valve gear.

No attempt was made to equilibrate the power developed in the high and low-pressure cylinders. With high powers and speeds, it was thought better to relieve the load on the crank axle, even if this meant some increase in the power developed in the outside cylinders.

Cylinders. — By increasing the boiler pressure to 20 kgr./cm² it has been possible to reduce the diameter of the high-pressure cylinders from 440 to 400 mm. (17 5/16 in. to 15 3/4 in.), but that of the low pressure remains 650 mm. (25 5/8 in.). The outside high-pressure cylinders are horizontal and are 2.230 m. (7 ft. 3 25/32 in.) apart centre to centre; the cylinders are inside, at an angle of 4° 0' 9" and their centres are 0.690 m. (2 ft. 3 1/8 in.) apart. The high-pressure cranks are consequently at an angle of 175° 59' 51" with the corresponding low-pressure. The high-pressure connecting rods are 3 m. (9 ft. 10 1/8 in.) long and the low-pressure 1.675 m. (5 ft. 6 in.).

Former blast pipe (I). 356-mm. (14 inches) chimney with clover type exhaust.

Double pipe with crossed bridges (XI)



Area of exhaust steam passages.

Blast pipe nozzle fully open	181 cm² (*28.0 sq. inches*).	Blast pipe nozzle fully open	274 cm² (*42.5 sq. inches*).
Blast pipe nozzle set at minimum opening	120 cm² (*18.6 sq. inches*).	Blast pipe nozzle set at minimum opening	181 cm² (*28.0 sq. inches*).

Fig. 6. — Comparative diagram of the original and new P. L. M. type double blast pipe.

Valve gear. — No change has been made in the motion which is the usual P.L.M. conjugated type with piston valves. The outside Walschaerts gear drives the high-pressure valves direct and the low-pressure through a rocking lever. This simplifies the inside valve mechanism, the design of the crank axle, and the reversing gear.

Consequently, on each side of the locomotive, a single valve gear motion actuates, on the one hand and directly, the high-pressure piston valve, and on the other, through a transmission shaft and oscillating lever, the piston valve of the corresponding low-pressure cylinder. The ratio of the high to the low-pressure cut-off is therefore not left to the driver, but the relative cut-offs are fixed in the shops.

The dimensions of the piston valves are given in the table of leading dimensions; the steam lap is the same for both high pressure and low pressure, and maximum cut-off is 79.75 % on the high pressure and 87.45 % on the low.

The intermediate reservoir has a capacity of 382 litres (14.12 cu. feet).

It should be noted especially that the steam passages to the cylinders have been increased and improved so as to reduce to a minimum losses through wiredrawing, bends, and changes of section. These alterations have made it possible to take full advantage of the increased pressure and the improved draught and reduced back pressure.

Wheels and axles Frame Spring gear.

No alteration has been made to the wheels and axles, frame or spring gear. The leading bogie has 60 mm.

(2 3/8 inches) lateral play each side, and the trailing truck has 66 mm. (2 19/32 inches); the tyres of the intermediate coupled wheels have been reduced in thickness by 10 mm. (3/8 inch) to facilitate running through curves.

The main frames are 1.234 m. (4 ft. 19/32 in.) apart and are 28 mm. (1 7/64 inches) thick.

The spring gear is arranged to give the usual 3-point suspension : bogie, coupled wheels having equalised plate springs, and trailing truck.

The trailing wheels are fitted with conjugated coiled springs arranged on each side of the axle boxes.

Miscellaneous.

A large-capacity compound pump provides the compressed air for the brakes.

The engine is fitted up for train steam heating.

Results obtained

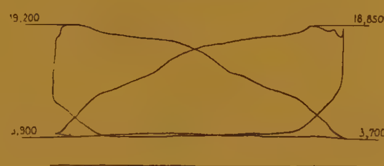
Special tests at constant speed have been made with locomotive No. 231-F-141 in order to ascertain the new characteristics of the engine, and its performance. The tests were made with the dynamometer car and at constant regulator openings between Laroche and Les Laumes (102 km. = 63.4 miles). Official long-distance trials [1] were then made between Paris and Lyons with a train weighing 430 t. (423.2 Engl. tons) behind the tender. The trials provided data as to the behaviour of the engine at different cut-offs, which showed that the altered engine was a great improvement on the old *Pacific* design. Whereas the 231 D could only produce a sustained drawbar horse-power of 1 600, the 231-F-141 engine gives at least 2 200 with a lower water and coal consumption. In addition, the fire remains in so much better order that the engine can run longer distances before the fire has to be cleaned.

Indicator diagrams are reproduced in figures 7 and 8 :

Figure 7, with 55 % cut-off in the high-pressure cylinders at a speed of 100 km. (62 miles) an hour;

Train No. 513 of the 16.5.33.
Speed, 100 km. (62 miles) per hour.
Blast pipe notch : 0.

High pressure.



Low pressure.

	Front end	Back end.	Total
Horse-power, h. p. . . .	906	874	1780
Horse-power, l. p. . . .	536	617	1153
H. p. + l. p..			2 933

$$\frac{\text{High-pressure horse-power}}{\text{Low-pressure horse-power}} = \quad . \quad . \quad 0.607$$

Fig. 7. — Indicator diagrams with :

55 °/ₒ cut-off, high-pressure cylinders.
and 69 °/ₒ cut-off, low-pressure cylinders,

(1) The official trials were carried out on the 19th June 1932 and described in the *Paris Lyons & Mediterranean Railway Bulletin* of September 1933.

Figure 8 with 50 % cut-off in the high-pressure cylinders at a speed of 119 km. (74 miles) an hour.

Train No. 513 of the 16-5-33.
Speed, 119 km. (74 miles) an hour.
Blast pipe notch No. 2.

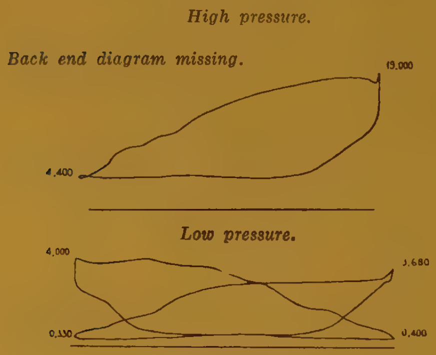


Fig. 8. — Indicator diagrams with:

50 °/. cut-off, high-pressure cylinders.
and 63 °/. cut-off, low-pressure cylinders.

In the first case the sustained horse-power is 2933; the low-pressure cylinders developing about 40 % of the total pressure, the exhaust back pressure in the low-pressure cylinders is 0.33 kgr./cm² (4.7 lb. per sq. inch).

In the second case, the indicated horse-power developed in the low-pressure cylinders is still 1063, only differing by 8 % from that in the previous test. This shows that the steam passages are amply large enough and that the engine is able to work efficiently at this speed.

During the official trials on the 19th June with a train of 430 t. (dynamometer car, seven coaches, and one brake van), the time taken to run from Paris to Lyons was 5 hours 7 minutes, including two stops for taking water (3 minutes at Laroche and 5 minutes at Dijon). Deducting stops, the average speed was consequently 102.5 km. (63.7 miles) an hour.

The diagrams (fig. 9) show the gradients of the line, the speed curve, the sectional times, the recorded tractive effort at the tender drawbar, the drawbar horse-power, and at specified points, the equivalent drawbar horse-power on the level.

On the Blaisy bank the equivalent drawbar horse-power varied between 2 000 and 2 350 H.P., and on several sections of the run the speed exceeded 120 km. (74.7 miles) an hour, the maximum speed reaching 133 km. (82.6 miles) an hour at certain places.

The total coal consumption was between 7.5 and 8 metric tons, 1 ton of which was used for lighting up; the water used was about 59 m³ (12 978 Br. gallons). With a 35-m³ (7 700-gallon) capacity tender which would cut out the Laroche stop, and a train weighing 330 tons (one dining car, 5 coaches, and 1 brake van) this locomotive could make the Paris-Lyons run in 4 hours 58 minutes, i. e. at an average speed of 102.6 km. (64 miles) an hour.

The average running speed of this 231-F-141 locomotive can be taken as 100 km. (62 miles) an hour, and the working conditions for this engine at this speed are:

55 % cut-off in the high-pressure cylinders;

69 % cut-off in the low-pressure cylinders;

Indicated horse-power . . 2 933

Tender drawbar pull (on the level). . . . 6 471 kgr. (14 266 lb.)

Effective horse power, at the tender drawbar (the level) . . . . 2 397 H.P.

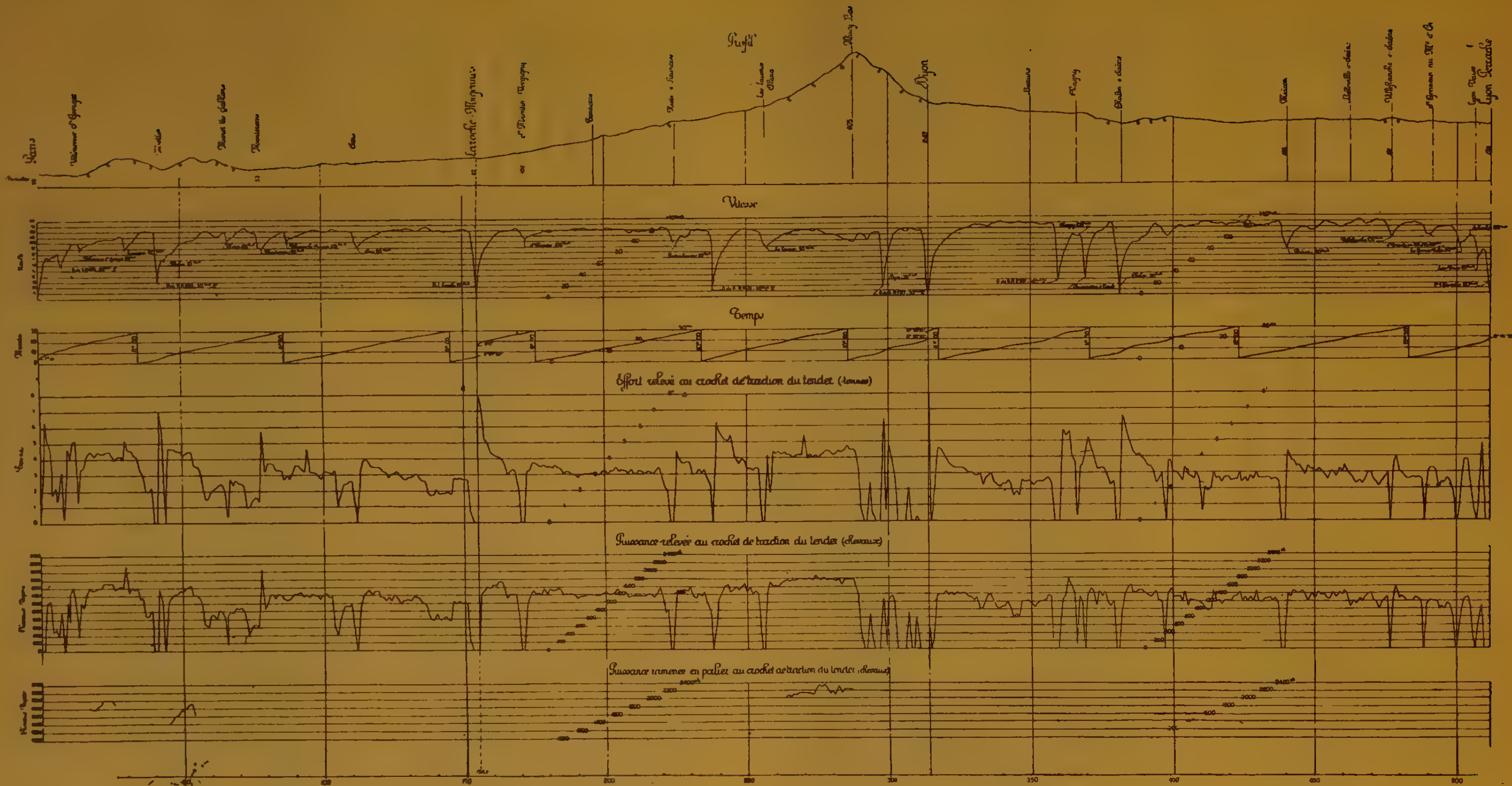


Fig. 9. — Graphic records of the P. L. M. special train of June 19th, 1933, with 430 t. (423.2 Engl. tons) behind the tender (dynamometer car trials).

Explanation of French terms:

Profil = Gradients. — Vitesse = Speed. — Temps = Time. — Effort relevé au crochet de traction du tender (tonnes) = Draw bar pull, in metric tons. — Puissance relevée au crochet de traction du tender (chevaux) = Recorded tender drawbar horse-power. — Puissance ramenée en palier au crochet de traction du tender (chevaux) = Equivalent tender drawbar horse-power on the level.

[621. 335 (73) & 621. 43 (.73)]

Union Pacific installs light-weight high-speed streamlined passenger train.

(From *Railway Age.*)

Fig. 1. — Union Pacific

Believing that the restoration of anything like a satisfactory volume of passenger business to the rails is dependent on the development of a radically different type of passenger equipment, the management of the Union Pacific System, early in 1933, authorized the expenditure of $ 200 000 for such a train which would provide safe, fast and comfortable transportation at a minimum cost. The order for this train was placed with the Pullman Car & Manufacturing Corporation, which co-operated in designing and has completed the building of the first three-car train. Driven by a 600-H.P., 12-cylinder, distillate-burning engine, with electric transmission, this train will be operated on special runs between the larger cities on the Union Pacific System, with the purpose of demonstrating its practicability for regular main-line through passenger-train service, including transcontinental.

While this first train does not have sleeping accommodations, it is expected to demonstrate its adaptability for long

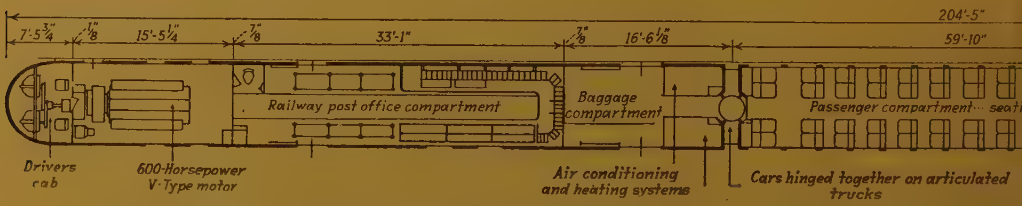


Fig. 2. — Floor plan of the three-car, articulated, high-speed train, built for the Union

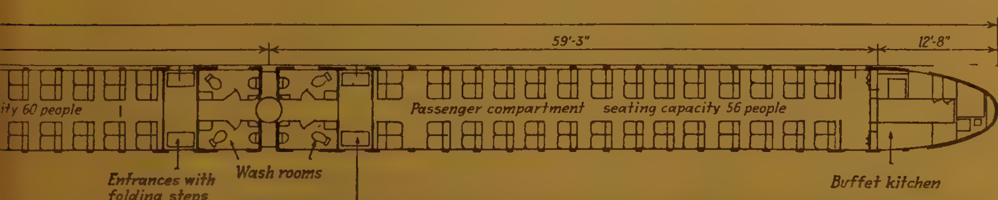
transcontinental runs, and a light-weight sleeping car, embodying the same general principles of construction, has already been designed. In fact, the Union Pacific has ordered from the same car builder a second train of six articulated cars, including a power car with a 900-H.P., 12-cylinder, V-type Diesel engine, a mail-baggage car, three Pullman sleeping cars and a combined coach and observation-buffet car. This train, like the first, will be of aluminum construction, completely streamlined and fully air-conditioned throughout. The three

ree-car, high-speed train.

Pullman sleepers, which will be built of aluminum alloy, not only will follow the exterior streamlined design of the new Union Pacific train, but will incorporate a number of innovations for the added comfort and convenience of passengers. Plans for the run on which the second train will be placed are still indefinite and cannot be determined until the train is completed and tested. Construction work on the second train is not yet sufficiently advanced to permit setting a date for its delivery.

Principal features of the three-car train.

The three-car train consists of a forward car, 72 ft. 8 in. long, containing the power plant, a 33-foot mail compartment and a small baggage room; a second car, 59 ft. 10 in. long, which is a coach, seating 60 passengers; and a rear car, 71 ft. 11 in. long, which is a coach, seating 56 passengers, with a buffet in the rear for serving light meals to passengers at their seats. The overall length of this train is 204 ft. 5 in., and its esti-



Pacific by the Pullman Car & Manufacturing Corporation and featured by aluminum construction.

mated weight, 170 000 lb. The train is about 8 inches narrower and the car roof 3 feet lower than in conventional car design, and this substantially reduced cross-sectional area, in conjunction with light weight, streamlined design, and the power plant provided is expected to permit developing a balanced speed of 90 m.p.h. on tangent level track and a maximum speed, under favorable conditions, of 110 m.p.h.

In the interests of safety at high speeds, the new train is designed with a low center of gravity, and provision is made in the truck design to assure easy riding under this condition. The bottoms of the cars are but 9 1/2 inches above the rails while the tops of the cars are only 11 feet above the rails. In the new train, the passengers are seated 16 inches nearer the ground than in the conventional train, and the center of gravity is 38 inches above the rails, or 20 inches lower than in the ordinary railroad coach.

The aluminum car bodies are tubular in shape, and form a deep, stiff beam, thereby requiring a minimum of material for a given strength. These car bodies are joined in an articulated construction which permits the three cars to be supported by, and operated on, four trucks, two less than would normally be required. The four-wheel truck frames are made of a special alloy cast steel and, with the steel wheels and axles, bolsters, special castings, power-plant parts, etc., constitute the only steel used in the train.

Other features of the train which are expected to prove of wide popular acceptance are : The air-conditioning for both summer and winter; safety glass windows, permanently set in rubber to exclude dirt; extensive use of rubber in the trucks to reduce noise and promote easy riding; attractive interior decorative scheme, coupled with unusually comfortable four-position seats, indirect lighting, buffet service, etc.

For maximum visibility, the exterior color scheme of the train is a golden brown on the canopied roof and the bottom of the train, with the sides finished in a canary yellow. Two headlights of special construction are provided, one having a horizontal and the other a vertical beam to give added protection from a visibility standpoint. A powerful siren with long audibility range will be used for high speeds, supplemented by the usual type of siren and a gong for use in towns, yards, etc.

Aluminum construction chosen for light weight.

A study was made of all available materials, including aluminum alloys, stainless steel and other steel alloys with physical properties, intermediate between ordinary steel and stainless steel. In order to obtain extreme light weight, the choice narrowed down to aluminum alloys versus stainless steel. It was finally decided to use aluminum alloys for the entire car structure except for the bolsters, articulation castings and truck frames, for which special alloy cast steel was used, having high tensile strength, high yield point and great ductility.

A number of factors led to the adoption of aluminum-alloy construction for this particular development, an important one being the possibility of using extruded metal shapes to take the place of the ordinary rolled shapes and pressings. These shapes are produced by forcing the hot metal through a die forming the cylinder head of the press. The Aluminum Company of America furnished all of the standard aluminum plates and shapes used in the new train and co-operated with the car-builder in producing all necessary extruded shapes. These shapes are said to be highly accurate in dimensions, permitting the designer to interlock various extruded sections to produce cars of a minimum weight, maximum strength and minimum

deflection with simple shop fabrication.

One of the drawings shows a half cross section of the light-weight train with the extruded sections indicated in the positions where they are used throughout the structure. Other reasons for the selection of aluminum-type construction are the fact that aluminum plates can be readily formed for the curved surfaces used in connection with streamlining and are readily fabricated in the shop.

Streamlining based on wind tunnel tests.

An exhaustive study was made in the matter of streamlining with the idea of reducing as much as possible the wind resistance with the obvious resultant economy in power requirements. Advantage was taken of work done along these lines in connection with aircraft development. This, however, did not take into account the effect of ground resistance. The streamlined design was determined as a result of a series of scientific tests with scale models in the wind tunnel in the University of Michigan at Ann Arbor, Mich. Wooden models of the train, built to a scale of 3/8 inches per foot, were provided with detachable fronts and rears. Various-shaped front ends and rear ends were constructed and all subjected to wind tunnel tests. Based upon the results obtained in these wind tunnel tests, the final form of the train was determined, and a fairly accurate estimate made of the power required for the speed desired.

Tests of the streamlined models indicated the desirability of a smooth canopy, closing up the gap between the sections, but the accomplishment of this was a difficult task, taking into account the relative movement between car sections on curves, etc. An aluminum shield extends from the rear end of the forward section toward the front end of the following one, which is the prolongation of the car contour. The extent of this projection is contingent on the minimum radius of the curve to be negotiated. Closing up this gap between the hood projection and the following car section is a rubber sheet rigidly attached to the following car section, assuming the contour of the car and free to move

Fig. 3. — A front-end view of the new Union Pacific train.

at its forward edge. Spring-actuated arms, mounted on the drum portion of the articulation with rollers bearing on the inner side of the projecting hood, keep this rubber stretched to close up the gap between the hood and the following car section.

To minimize air resistance still further, all trucks are shrouded, wind-tunnel experiments on scale models having developed that the total air resistance

of the train was thus capable of being reduced about 20 % from the truck shrouding alone.

Another factor in reducing air resistance at high speeds is the fact that all windows and doors are set flush, as nearly as practicable, with the exterior of the train. Coach doors, conforming to the exterior contour of the cars, are hinged and swing outward. The mail and baggage doors are opened by a special device which first moves the entire door inward several inches and then slides it open lengthwise of the train on the inside. The coach side doors are interlocked with steps which fold up and down as the doors are closed or opened. A flush trap door inside the car synchronizes its operation with the movements of the corresponding door and steps.

Features of the structural design.

In order to secure the greatest strength with the least amount of material, a tubular cross section for the train was adopted, with the outer surfaces of aluminum sheets and framework built up of extruded aluminum-alloy sections. All of the metal in the framing is coordinated to act as a unit, whether for draft or buff, as it is impossible to deflect or stress any member without having adjacent members bear their proportion of the stress. This differs widely from the ordinary form of car design in which draft or buffing shocks are taken care of by longitudinal underframe members. The conventional underframe transmits certain loads to the side frame and the roof, but, due to its design, only part of its area can be utilized for load-carrying; in other words, much of the material or section in the conventional type of car construction does not take its proper part of the stress.

By making the cross section of the car a tube, a large moment of inertia was obtained, which means closely controlled deflections, compensating for the high deflections otherwise produced by the low modulus of elasticity of aluminum. The basic principle which the Pullman Car & Manufacturing Corporation developed in designing cars of this type is that gusset connections should be avoided; all longitudinal members should extend the entire length of the car section; and transverse members should be in one piece for at least one-half of the cross section.

Fig. 4. — Typical massive aluminum framing construction at the front of the train.

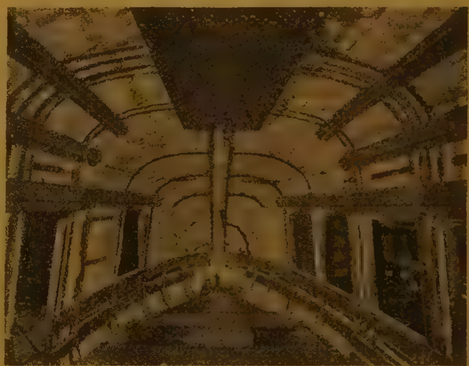


Fig. 5. — Interior view showing car-end details, including the application of Rokflos insulation.

As will be noticed from the full cross section, illustrated, a duct is located below the roof, extending the entire length of the car and being used as an air duct, also containing lamps for the indirect light. This duct acts as an effective compression member. It will be noted that the underframe portion of the cross section is an I-beam built up of extruded metal and truss bracing. This, due to its shape and connections, forms an effective tension member which co-ordinates with the compression member in the roof.

Moreover, the tubular design, which lends itself to economy in material requirements, also conforms to the best shape as developed in connection with streamlining, reducing materially the retarding effect of side or quartering winds. It has been determined that a quartering wind confronting the train from either side actually offers the greatest resistance because of the larger

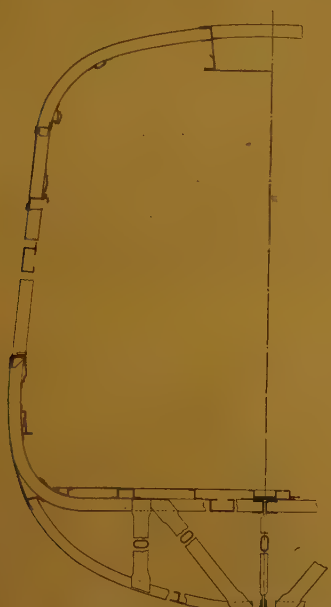


Fig. 6. — Cross-section of framing, showing various extruded sections used for the structural members.

surface area presented to forces present in the air current.

Whenever light-weight equipment has been proposed, the usual reaction of experienced railroad men is to stress the hazard encountered at grade crossings when colliding with automobiles, trucks, etc. In order to protect against damage under such conditions, the front end or nose of this train was given special consideration. About half of the total

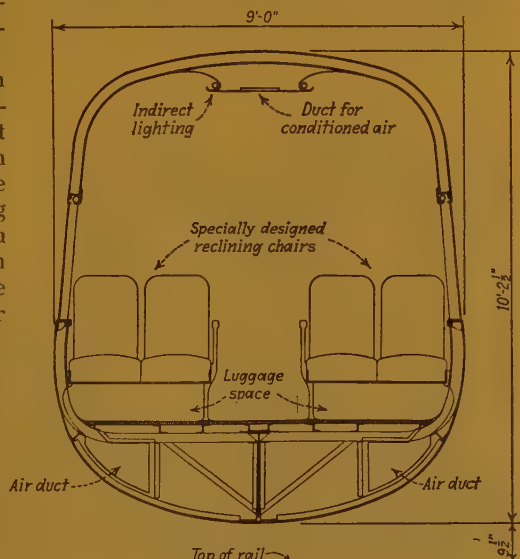


Fig. 7. — Cross-section of the passenger compartment.

weight of the train, or 85 000 lb., is carried on the front truck, which necessarily requires a massive support for the engine at the floor line. This floor line construction forms the center of the curved front end, and all of the structural members converge to form a strong parabolic arch, which should resist without damage the shock of any collision possible at highway crossings.

Articulated construction of the car bodies.

Articulation between body units of the train was adopted as best suiting the

requirements for high-speed and smooth riding. It eliminates the objectionable overhang of non-articulated cars, also the necessity for couplers and draft gears and complicated vestibule arrangement. It prevents, except to a limited degree, the independent oscillation of each individual car, thus tending towards a gliding motion of the entire train. It also permits of carrying three cars on four trucks in place of six trucks, thus reducing track resistance as well as inspection and maintenance, and, incidentally, construction cost and weight.

Fig. 8. — Aluminum framing details and integral Hylastic steel end-sill and articulation casting.

Articulation is effected by attaching an extension steel casting to each adjoining end sill, these castings terminating in center plates which rest one on top of the other. The two center plates in turn rest on the truck center plate. These special castings are made of Hylastic steel, furnished by the American Steel Foundries. All center plates are lined with Oilite bronze to reduce friction. Side bearings spaced on each side of the center plates are of special design, incorporating the use of rubber in shear, to deaden oscillation and contribute their share toward smooth riding. Conditioned air is transmitted through the articulated connection between the cars by means of flexible bellows, furnished by E. I. Du Pont de Nemours & Co. The

Fig. 9. — View showing the passageway through the articulated connection between the cars.

usual electric trainline connectors are provided between the cars, and air and water lines are carried in metallic hose through an insulated telescoping tube construction.

Truck design involves extensive rubber cushioning.

All trucks are of the four-wheel type, with Commonwealth cast-steel frames made by the General Steel Castings Corporation, and rolled-steel wheels and axles furnished by the Illinois Steel Company. The front or power truck has 36-inch wheels, equipped with S.K.F. roller-bearing journals, placed outside of the wheels in order to provide space

necessary for the two motors geared one to each axle. The armature shafts are also on roller bearings, the armatures being wound for a safe maximum speed of 110 m.p.h. The remaining three trucks have 33-inch rolled-steel wheels and inside-type S.K.F. roller-bearing journals to reduce the truck width and minimize air resistance. All roller bearings are liberally oversize for the weight and speed requirements of this train.

An intensive study was made of the basic requirements for a truck suitable for service with a train of this type. The Pullman Car & Manufacturing Corporation, by the use of extensometers and deflectometers, made a study of truck action to obtain a true basis for correct design, resulting in low uniform deflections in connection with low uniform stresses for all parts of the structure. This insures, under dynamic conditions, the same safety as is indicated by the usual calculations covering static loading. The truck structure, made with the frames and transom cast in one piece, was designed by the General Steel Castings Corporation in collaboration with the Pulmann Car & Manufacturing Corporation. An alloy cast steel was used, having a minimum yield of 50 000 lb. per sq. inch and of high ductility.

The truck design is based on extreme cushioning by means of rubber, furnished by the United States Rubber Company, which is arranged to take the dynamic rather than the static loads. There is no metallic contact between the journal box and the truck frame. Two wing castings, which in effect are a part of the journal box, extend out from the

Fig. 10. — One of the trailing trucks.

box in each direction, one on each side of the frame and parallel to it. Between these wing castings and the frame, both in front of and behind the axle, are rubber doughnuts, applied with sufficient compression so that the rubber has capacity in shear to take its part in supporting the load on the truck. The doughnuts keep the wing castings from contact with the side frame and control both the longitudinal and lateral motion of the journal box with respect to the frame. Acting in parallel with the rubber doughnuts are coil springs placed between the outer ends of each pair of wing castings and the side-frame member. For ordinary static loads only a small proportion is borne by the rubber doughnuts, amounting to not more than about 8 lb. per sq. inch on the rubber. The major portion of the static load is borne by the coil springs, but the load curve of the rubber doughnuts is such that for impact or live loads the greater portion is taken by the rubber.

The swing hangers do not have an

exaggerated angularity, so small inequalities in the track can be readily taken care of by lateral motion without any great resistance. Extreme lateral forces are taken care of by Lord rubber bushings which regulate the movement

Fig. 11. — The power truck of Commonwealth cast-steel construction, S.K.F. roller bearings and a special spring suspension.

and resistance of the bolster laterally so as to parallel the effect of the swing hanger angularity or gravity resistance after a slight movement of the bolster has taken place, and to greatly augment this resistance for extreme forces. The delayed action of the rubber lateral motion device is such that the ordinary gravity return is not reinforced by the rubber return, as this action is a delayed one and takes place considerably later than that produced by gravity itself.

The chafing plates ordinarily used between truck bolster and transom are present, but are not rigid. A small amount of movement is provided by rubber packing to cushion the movement due to acceleration and deceleration. All coil springs are mounted on rubber pads especially designed to soften the shocks and « kill » metallic contact.

The side bearings are box receptacles mounted on the truck bolster and provided, as mentioned, with rubber in shear to cushion the fore and aft motion, also all vertical motion of the car bodies when rounding curves or encountering track inequalities. With this design, the side bearings are always in contact, with due provision for cushioned and controlled lateral motion.

The truck brake rigging is of clasp brake construction on the motor truck. Brake cylinders are truck-mounted, and the truck application is such that each axle is braked separately by its own cylinder without connecting the brake rigging between the two axles. The truck cylinder pressures, however, are equalized. All brake shoes are of the unflanged Diamond S type, furnished by the American Brake Shoe & Foundry Co.

On the trailer trucks, due to the limited weights on the trucks, the single shoe per wheel brake system is installed. As in the case of the power truck, each pair of wheels has its own brake system, with the cylinder truck-mounted. The truck brake rigging on all trucks is designed so that the application pressure of the brake shoe is independent

Fig. 12. — Cab signal receiver mounted behind the protective apron and just ahead of the front wheels of the power truck.

of the action of rubber between journal box or wings and truck frame. Where possible, aluminum has been used for brake rigging parts, brake cylinders, also for valves and all piping. It is interesting to note that the weight of the entire air-brake equipment on this train is only 608 lb. for the power car, 179 lb. for the second car and 283 lb. for the third car.

Details of the power-plant installation.

The power plant in this train, including the engine, electric transmission,

controls, etc., was designed and supplied by the Winton Engine Corporation, Cleveland, Ohio, a division of the General Motors Corporation. The prime mover is a 12-cylinder, V-type engine, with 7 1/2-in. by 8 1/2-in. cylinders, rated at 600 H.P. at 1 200 r.p.m. The entire rated horsepower is said to be available for propulsion of the train, the engine delivering sufficient horsepower in excess of the rating to provide power for all train auxiliaries, such as cooling fans for the power plant, air-conditioning, lighting, etc.

Fig 13. — Winton 600-H.P., 12-cylinder, V-type engine, with direct-connected Westinghouse 425-kw. generator.

The engine was designed primarily for this train and incorporates some features not heretofore used. It is designed to utilize the Duff system of distillate burning which is standard on the Union Pacific System. Special features in the engine design include a cylinder block and crank case made entirely of rolled-steel plate welded into one piece by the Lukenweld process. The main framework of the engine is, therefore, one solid piece, to which a light oil pan, cast-iron cylinder heads and other accessories, are attached. Cylinder liners are of hard cast iron, pressed into the welded steel framework and readily replaceable.

The wearing parts of this engine are readily replaceable, thus promoting long engine life. Cylinder heads are of cast iron with valves in the head. There are two exhaust and two intake valves and four spark plugs in each cylinder head. The cam shafts are located on the outside upper corners of the main framework, and the Duff distillate carburetors are mounted on the outside of the V-type cylinders. The exhaust connections have an individual pipe for each cylinder and are taken off vertically upward at the inside of the V.

Accessories, which include a double lubricating oil pump, water pump, governor, hydraulic relay for throttle control and four ignition distributors, are mounted on the end of the engine farthest from the generator. These accessories and the two cam shafts are driven from the crankshaft by a roller chain. The engine drive to the generator is through a torsionally flexible coupling.

The pistons are of aluminum alloy and

General dimensions of the Winson model 191-A distillate burning engine.

Horsepower rating	600 H.P. at 1 200 r.p.m.
Number of cylinders	12 cylinders, 60° V-type.
Bore and stroke	7 1/2 inches by 8 1/2 inches.
Crankshaft	Special counterbalanced.
Main bearings	Seven, 5 1/2 inches diameter — High lead bronze.
Pistons	Aluminum alloy.
Connecting rods	Drop forged.
Rod bearings	Twelve, 43 3/4 inches by 3 inches. — Babbitt.
Engine block	Fabricated steel.
Crankcase	Fabricated steel.
Cylinder heads	Individual cast.
Exhaust valves	Dual; diameter 2 3/4 inches.
Intake valves	Dual; diameter 2 3/4 inches.
Valve tappet adjustment	Automatic.
Cam shaft	Integral cams, hardened and ground.
Cam-shaft bearings	Seven; line bored; 3 1/8 inches diameter.
Cam-shaft drive	Flexible chain, automatic adjustment.
Engine auxiliaries. Mechanical governor. Dual oil pump. Quadruple ignition. Large-capacity water pump.	Mounted on gear case; spline drive.
Carburetion	Duff.
Engine lubrication	Forced feed throughout; crankcase supply.

the connecting rods are H-section drop forgings of alloy steel. The connecting-rod big-end bearings are cast directly into the rods. The main bearings of the crankshaft are removable liners.

The electrical equipment, consisting of a generator, traction motors and control, were designed for this particular power plant. The generator and control apparatus were manufactured by the Westinghouse Electric & Manufacturing Company, while the traction motors and air compressors are of General Electric Company manufacture.

The generator, rated at 425 kw., is directly connected to the engine. This generator carries a built-in exciter so designed that the current demand of the traction motors regulates the amount of generator voltage in such a manner that the load on the engine is constant at any car speed, and solely under control of the engine throttle. The two 300-H.P. traction motors, mounted on the front truck and geared to the wheels, are of a new, roller-bearing type, incorporating features of design necessary for the high speeds at which this train will operate. Cooling air for the traction motors is carried to the motors through a special air-cleaning and ventilating system which assures air being forced through the motors at all times.

The streamlined characteristics of this train necessitated the development of a cooling system which differs radically from the conventional type heretofore used on motor cars, as it was no longer possible to locate them on the roof of the car. The system developed for this car provides for the radiators being located below the engine-room roof. Air is brought in from the front of the car through a duct, as far as the partition dividing the engine-room from the operator's cab. At this partition, two fans, driven by the engine, force air into the engine-room under sufficient pressure to pass it out through the radiators. This treatment of the air assures a minimum disturbance of the air stream past the train, a thoroughly-ventilated engine-room, a cooled exhaust manifold and an immediate dilution of exhaust gas as it leaves the exhaust stack.

The water for the engine-cooling sys-

tem is kept in a tank in the rear of the engine-room and in the engine jackets themselves. Thus, when the engine is stopped, the water drains from the radiators into this tank, affording protection against freezing in cold weather. A feature of the engine cooling system is its freedom from excess piping.

Fuel is lifted from the fuel tanks to the carburetors by means of a motor-driven fuel pump, with a return system for returning excess fuel to storage tanks. The Exide-Ironclad MVAH-17 storage battery, furnished by the Electric Storage Battery Company, consists of 32 cells arranged in two groups of 16 cells each, connected in series and furnishing current at 64 volts, the voltage of the lighting and auxiliary power circuits.

A special auxiliary generator of Winton design, driven from the end of the main generator shaft and having a maximum capacity of 25 kw., is used for charging the storage battery, which in turn provides power for all control, car-lighting, ignition, heater, motors, pumps, air-conditioning, etc. The voltage of this auxiliary generator is constant at all speeds, including idling. A 7 1/2-kw. Kohler engine-generator set, mounted in the baggage compartment, furnishes power for battery charging, heating, cooling and lighting when the main engine is shut down for any extended period.

The lubricating oil for the engine is supplied by a twin-gear pump which is a part of the engine. One section of this twin pump takes oil from a storage tank and delivers it into an oil passage in the cylinder block, from which it is carried to every working part of the engine. The pressure in this oil passage is used to open the engine throttle so that the engine cannot be operated above idling speeds without sufficient oil in the lubricating system to prevent damage to working parts.

The engine control consists of an engine throttle directly under the operator's hand. The transmission control consists of a master controller located directly under the engine throttle. This master controller directs the movement of electric and air-operated contactors and the reverser controlling the connections to the two traction motors for forward and backward motion of the car.

Fig. 14. — View in the operator's cab showing control mechanism, air-brake gage, two-indication type cab signal, window wiper and safety glass.

In the operator's compartment are located the various gages, such as air brake, engine temperature, G. E. speed indicator, etc., so that the operator may be familiar at all times with the exact functioning of all parts of the power plant. An electric buzzer system affords communication between the train crew and the operator.

Brake equipment includes novel features.

The air-brake equipment for this train was especially designed and built by

the New York Air Brake Company. In order to avoid rearranging the signaling system and also to avoid any additional operating hazard, it was necessary to be able to stop this train from 100 m.p.h. within the same distance that a conventional steam train could be stopped from the ordinary speeds at which it operates.

Heretofore, uniform braking retardation has not been possible, due to the fact that the coefficient of friction between brake shoes and wheels varies with the speed through a wide range, this coefficient decreasing rapidly at the higher speeds. In order to provide a uniform rate of retardation, it is necessary to control brake-shoe pressure automatically in proportion to the speed. In the new brake, this is done by automatically controlling cylinder pressure by a simple but effective device recently developed and thoroughly tried out, and known as a « decelerometer ». This instrument consists essentially of a movable weight of about 100 lb., sensitively mounted on ball-bearing rollers and arranged to move in the line of motion of the train, and suitably restrained by a calibrated spring. This weight, acting through suitable leverage and a pneumatic valve, controls the brake-cylinder pressure accurately in proportion to its inertia, and, therefore, in proportion to the retardation of the train. Recent tests with this device on a gas-electric motor car developed a straight line retardation graph from 76 m.p.h. to rest.

With high rates of deceleration up to the point at which the vehicle comes to rest, the sudden change from high deceleration to a state of rest would result in a noticeable jolt at the end of the stop. In order to eliminate this, the decelerometer is provided with an ingenious valve device which changes the rate of deceleration to a low value just previous to the stopping of the vehicle. This results in a sudden final reduction in cylinder pressure to prolong the smoothness of deceleration to the end of the stop.

The decelerometer control is designed to assure stopping distances from exceptionally high speeds shorter than are obtained on steam railroad trains running at much lower speeds, without the slightest discomfort to the passengers and providing insurance against slid-flat wheels.

The air brake used on this train is a complete departure from conventional practice, both in its circuit and the individual design of the various valves and parts used. The pneumatic feature is based on a two-pipe circuit consisting of a supervisory line and a control line. The supervisory line distributes the air to the reservoirs under each car and charges to the maximum pressure at all times. In conventional brakes, it is not possible to charge the reservoirs during brake application. The purpose of the control line is to apply and release the brakes by admitting air to the pneumatic relay valve under each car, this valve controlling communication between each brake cylinder and its adjacent reservoir, and from the cylinder to the atmosphere. This control line passes from the operator's brake valve through the decelerometer valve to the relay valve. This briefly describes the pneumatic operation, Parallel to this pneumatic circuit lies an electric circuit actuated by contact points on the brake valve, which operates a magnetic control feature on each pneumatic relay valve. This not only synchronizes but accelerates all brake applications and releases.

The use of a straight-air brake system demands adequate protection against operating failures in case of pipe rupture or other unforeseen causes. To overcome this, the relay valve units are so constructed as to insure proper operation upon the depletion of pressure from both the supervisory and control lines. If the electric circuit should fail from broken lines or other causes, the pneumatic elements in the system will function in the usual manner to supply adequate braking power.

Air-conditioning and ventilation.

An air duct is carried throughout the train on each side below the floor line, and there is also a central ceiling duct throughout the train, all of these ducts being connected between the cars by flexible bellows. Heat is obtained by passing air through the radiators of the engine, this air being forced by blowers through the floor ducts, there being a radiator outlet at each seat. Air is exhausted through a corresponding opening in the ceiling duct so that a definite circulation is obtained at each seat unit.

Fig. 15. — Engine-room view showing accessories mounted on the end of the Winton engine.

Two oil-fired hot-air furnaces, supplied by the Vapor Car Heating & Lighting Co., are installed, one on either side of the baggage compartment, being designed to heat the train under all conditions, should there be a failure of the heat from the engine radiator. They also provide heat for the cars at terminals or in the yards when the engine may not be operating. These oil-fired heat-generating units weigh 580 lb. each and, at a rate of 1 250 cu. feet per min., have a capacity to deliver up to 135 000 B.T.U. per hour. The overall dimensions of each complete unit, as installed, are 19 in. wide by 40 in. high by 38 in. long, including the floor space required for the oil burner. Each complete unit comprises a combustion chamber, special radiator, or heat exchanger, smoke hood with stack switch and smoke stack with draft adjuster, and the oil-burner equipment. This gun-type burner, with electric ignition and directly-connected pump and fan, is arranged for burning distillate oil at pressures from 80 to 160 lb. under the control of an adjustable pressure-regulating valve. Adjustments of both the oil pressure and the air supply are easily made while the burner is in operation. The burners are designed to operate with either D.C. or A.C. current and, in the former case, have motors which also generate A.C. current, stepped up by a transformer to approximately 10 000 volts for ignition purposes.

Heating thermostats are provided, one on each side wall of the second car, with three tubes each for low, medium and high temperatures, controlling the operation of the oil burners for the corresponding side of the train. A thermostat on the switchboard locker side of the car contains an additional tube which automatically controls the motorized dampers, admitting heat from the engine-room. Temperatures are similarly controlled in the mail compartment of the first car and also in the third car. All heating thermostats operate through relays mounted on a control panel located in the baggage compartment of the first car; and these relays, in turn, operate either the motorized dampers or oil burners.

The air-cooling system, with a refrigeration capacity equivalent to the production of 7 1/2 tons of ice in 24 hours,

is an adaptation of the Pullman mechanical system to the special requirements of the U. P. three-car train. A Freon compressor, made by the General Refrigerator Company, Beloit, Wis., is driven by a direct-connected Louis Allis 12-H.P. D.C. motor. This power unit, together with necessary air-cooling equipment, is installed in the baggage room. For cooling the cars, the direction of circulation of the air is simply reversed from that used in heating, the cold air being discharged from the central ceiling duct and exhausted through the two floor ducts, shown in one of the illustrations.

A cooling thermostat is located on the side wall of the second car, with three tubes for low, medium or high, controlling automatically the operation of the cooling compressor. This cooling thermostat also operates through a relay mounted on the control panel.

General method of insulation.
Safety glass in the car windows.

An important factor in the maintenance of satisfactory temperatures in this train is the type of insulation installed, and this question was given careful consideration by the designers. The entire train is insulated with a two-inch thickness of Rokflos insulation, furnished by the Union Asbestos & Rubber Company. This material consists of a white mass of long, fine mineral fibers, closely interwoven to the required thickness and backed on both sides with an all-asbestos open-weave cloth. This type of insulation was selected on account of its notably light weight, high insulating value and sound-deadening properties, together with the fact that it also possesses the other important requirements of being permanently fire-proof, water-proof and vermin-proof. Rokflos insulation was applied on the floors, sides, ends and roofs of the cars and held in place by small-diameter wires running lengthwise of the car. This material was also used for insulating all of the air ducts in the train.

The floors of the cars are of aluminum alloy plates, built into and forming a part of the structural work of the cars themselves. These plates in turn are covered with Magnesite, a composition flooring, on top of which the final flooring of cork tile is laid. The cork tile, in natural colors but of light and dark shades, lends itself admirably to the comfortable appearance of the interiors of the cars. The composition flooring and the cork tile form a part of the general insulation of the cars and are an important aid in the reduction of sound from train operation.

To provide an additional safeguard for the passengers, all coach windows are made of Duplate safety plate glass, 7/32 inch thick, manufactured by the Pittsburgh Plate Glass Company. Duolite, another product of this company, is used for all transom lights. As the name implies, Duplate glass comprises a laminated construction, in which two plates of especially-selected plate glass are joined under a hydrostatic pressure of about 190 lb. per sq. inch and a temperature of 250° F. to a plastic filler which forms a bond to hold the glass together in case of rupture. The glass is manufactured under a formula which makes it not only shatter-proof but keeps out sunlight glare by the exclusion of ultra violet rays. As a result of extensive research and experiment, Duplate has been developed to a point where it is said to retain its safety features over long periods without appreciable deterioration. Sample plates of all glass used in the U. P. three-car train were subjected to the impact test, boil test, baking test and light-transmission test before installation.

Interior decoration, lighting and seating.

The interior design and decoration are simple but striking, developed by

Sterling B. McDonald, art director for Karpen Bros., Chicago, in conjunction with the Pullman Car & Manufacturing Corp. A passenger walking down the aisle toward the buffet is impressed with the ingenuity of the architectural design which gives the compartment the appearance of an entirely separate section of the car. This is accomplished by a bulkhead construction that blends into the general interior decorative effect of the car. This bulkhead begins immediately above the center, on either side of which are illuminated glass cases for the display of cigars, cigarettes and fruits. Over the grille is a special canopy with exhaust fans which prevent any odor of cooking penetrating the car.

The interior color scheme is blue, shading down progressively from nearly white at the top of the vaulted ceiling, through the lighter shades of blue to a dark blue color below the window sills. The colors are all metallic. Horizontal lines of aluminum show between the different shades of blue. The trimming on the chairs is of aluminum. The window sills are Micarta, a black Bakelite furnished by Westinghouse. The chairs are upholstered with a golden-brown tapestry, made by Wm. Wiese & Co., New York. The curtain rollers are entirely concealed, and the curtains, themselves, are of Venetian blind design, with fabric made by the Orinoka Mills, New York. The tile floor is covered with a harmoniously colored carpet aisle strip.

The 64-volt lighting system is entirely indirect, the electric globes being concealed in the aluminum panel construction running the entire length of the ceiling of the cars. The light is uniformly reflected on each side against the ceiling cove which has been properly curved, so that, in combination with the color scheme, the illumination is evenly distributed at the reading position. The lights are so arranged that three intensities are obtained, the lowest intensity being for night lighting while passengers are sleeping.

The car seats were especially designed by the Pullman Car & Manufacturing Corp. for this equipment, the aim being to secure the maximum of comfort, together with style and attractiveness,

Fig. 16. — Interior view showing the seating arrangement in the cars.

While the seats are arranged in pairs on either side of the aisle, each seat is an individual unit and may be reclined without reference to that adjoining. The seat backs are adjustable to three positions, the lowest being especially comfortable for sleeping. A foot rest adds to the comfort of the passenger.

The seats are equipped with devices for quick installation of an individual tray for each seat at the proper location for the service of meals from the buffet or for use as an individual writing desk. Ash trays are placed at each seat for the convenience of those who desire to smoke. The space beneath the seats is kept clear to provide storage space for baggage, the overhead baggage racks of the conventional train having been eliminated. At either side of the aisle in the forward end of each car, the seating

arrangement provides facilities for those who desire to play cards.

Buffet service provided.

A novel feature of the new train is the buffet kitchen which is built into the end of the last car of the new train. Triangular in shape, the buffet, though small, is nevertheless replete with space-saving devices to render complete service for the preparation of light meals. Stainless steel, furnished by the Allegheny Steel Company, is extensively used in this buffet. A Stearnès oil-burning range is provided. Across the front of the buffet is a counter from which drinks can be served. On one side is a refrigerated box for carrying ice creams, cooling refreshments, etc. On the other side are two coffee urns, a grill and other cookery apparatus. The electric ice box, provided with General Electric mechanical-refrigeration equipment, is built directly into the end of the car.

The passengers are served at their seats in the cars. The tray and table, when not in use, can be folded compactly for storage. The same supports and trays can also be used by the passenger as a small writing desk at the seat, if desired. In the service of meals, the waiters pass through the aisle with what is, in effect, a tea wagon with a steam table top and lower shelves for dishes, silverware and linen of a special weave.

The dishes on the new train are themselves worthy of note. Blue and yellow are the color motifs of the service, but the dishes, instead of being of china are made of the latest development in such ware. They are a special composition of the sort known as Beetleware, light in weight, graceful in design and colorful in appearance. The new train has the distinction of being the first train in America to employ this sort of service for meals. It is noteworthy that the total weight of the dining service of the new train, namely, the dishes, cups, saucers and glasses, aggregates only 189 lb., which may be compared with 530 lb. for the usual china service of a conventional train.

An auxiliary ice box for the storage of natural ice is arranged behind the electric refrigerator, the auxiliary supply being additionally available for refrigeration while the train is in terminals.

Two wash- and toilet-rooms are built into each car, these being located in the ends of the cars. The most modern type of sanitary equipment and fittings are installed. The wash-stands are of white metal. In the women's wash-room, there is a large built-in plate-glass mirror and dressing stand. Wash-stands and toilet-rooms are also installed in the first car of the train for the use of members of the crew.

Special headlights. — Cab signals installed.

The double-beam headlight used on the Union Pacific streamlined train was developed by the Pyle-National Company, Chicago, to conform to requirements of the railroad. It comprises both horizontal and vertical light beams, the horizontal headlight performing the normal functions of a locomotive headlight, and the vertical headlight serving as a distinctive marker.

The vertical marker beam will be seen plainly from a distance, and serve to herald the approach of this unusually high-speed unit from a great distance, and more definitely than would be the case with the standard horizontal headlight alone. The vertical beam will be visible off to the sides of the right of way, while the horizontal beam is confined to a comparatively small area forward.

The vertical headlight has a 10-inch silvered glass reflector, and the horizontal headlight a 12-inch reflector of the same type. Both headlights use special 75-volt lamps, the upright light having a 100-watt lamp and the forward light a 250-watt lamp.

The double headlight unit furnished by the Pyle-National Company, comprising reflectors and their mountings, lamp stand, and focusing devices, is completely built in, the housing being formed as a part of the car-roof streamlining of the front end of the train.

The classification lamps shown in the front-end views are likewise built in, the lenses being flush with the streamlining at the front end. These classification lamps are a modification of the Pyle-National air-craft navigation lights or wing lights. Clear, refracting-type lenses are mounted flush with the skin of the car, without interference with the streamlining. While it would appear that the light beam would point off to the side of the car, the refracting-type lens directs the beam forward, the effect being the same as with a standard classification lamp. These classification lamps are equipped with 5 1/2-inch reflectors, and a movable shutter between the reflector and the lens provides for showing either white or standard green indication.

Marker lamps at the rear end are of the same design, built in flush with the streamlined skin of the car. The lenses of these lamps are standard red instead of clear, and the lamp is without the shutter mechanism, as no change of indication is required.

The train is equipped with cab signals, the same as used on steam locomotives, and these signals will be operative in the territory equipped for cab signaling extending between North Platte, Neb., and Cheyenne, Wyo. The cab signaling is of the two-indication type, furnished by the Union Switch & Signal Company The signal is mounted horizontally on the front wall near the center of the cab, so as to be within the line of vision of both the engineman and fireman. The cab signal has two indications. The one at the right displays a green aspect when the track ahead is clear for at least two blocks, while the one at the left displays a red-over-yellow aspect when traveling in a caution or occupied block. In addition to these visible indications, an audible signal is provided in the form of an air whistle which starts to blow when the cab signal indication changes from green to red-over-yellow, and continues to blow until the engineman operates the acknowledging switch, located on the right wall of the cab near his seat. The whistle and the magnet for the control of the whistle are mounted below and to the right of the engineman's seat.

The receiver is mounted as usual ahead of the front wheels of the train, and is behind the protective apron. The design of the train made it necessary to shorten the receiver bar by cutting off 4 inches at each end. Likewise, it was necessary to mount the receiver 12 inches above the rail instead of the customary 6 inches. In order to compensate for these two changes, the amplification of the voltage picked up from the rail was increased. The equipment box, which contains the amplifier and relay equipment, is in the engine-room, being mounted on the forward wall about 3 feet above the floor. All conduits are made of aluminum.

No special equipment for shunting the track circuits is provided on this train, it being anticipated that the weight on the front truck will afford a shunt, which, together with the wheels on the six axles on the remainder of the train, will provide adequate shunting.

[621. 132.3 (.43)]

High-speed streamlined steam locomotives,

designed by Henschel & Sohn, Kassel.

(*The Railway Engineer.*)

Among the special types of high-speed railcars which have hitherto been built in Germany, as a contribution to the attainment of higher average speeds on railways, and to meet the changed conditions brought about by progress in road and air transport, particular interest has been aroused by the Flying Hamburger, the Krukenberg rail Zeppelin, and the Micheline light-metal car. In each of these vehicles the driving power is provided by internal-combustion engines and, in some quarters, it has been more or less tacitly assumed that this type of engine is essential to the realisation of high speeds in railcar and train service. Evidence that this is by no means the case is to be found in the remarkable forms of construction shown in the accompanying illustrations, which relate respectively to designs for a 4-6-4 four-cylinder compound, superheated, express locomotive capable of 150 km. (93.2 miles) an hour, and for a light steam train to run at speeds up to 160 km. (99.4 miles) an hour.

These designs have been developed by Henschel & Sohn A.G., Kassel, to whom we are indebted for permission to reproduce the accompanying illustrations. This firm has devoted continual attention to the correlated problems of reductions in weight, streamlining, and improvements in propulsion tending to the economic maintenance of high speeds. In this connection, it may be recalled that a Henschel locomotive built as long ago as 1904 attained a maximum speed of 155 km. (96.3 miles) an hour hauling a train of 160 metric tons (157 1/2 tons) on the Spandau-Hannover track. This performance was the more creditable as the principles of streamlining were then imperfectly understood. There was, however, no commercial need for such speeds at that time.

Streamlined steam locomotives.

Under existing conditions, higher railway speeds have become a necessity and, in recognition of this fact, the German State Railways recently invited certain German builders to submit designs for

Fig. 1. — Design for a 4-6-4 four-cylinder compound express locomotive prepared by Henschel & Sohn A.G., Kassel, for the German State Railways. This partly streamlined locomotive is intended to haul a 246-ton train at 93 m.p.h.

Fig. 2. — Alternative design for express locomotive. The distinctive features in this case are the complete streamline enclosure of the locomotive and tender, the leading cab and firebox, and the use of oil firing.

express locomotives capable of hauling trains of 250 t. (246 Engl. tons) at a speed of 150 km. (93.2 miles) an hour. Two designs were prepared by the Henschel firm, the first (fig. 1) for a 4-6-4 express locomotive of normal construction except that the projecting parts are enclosed by streamlined casings to reduce air resistance; the second (fig. 2) providing for the streamline enclosure of the whole locomotive and tender. In the second case, the driver's cab is placed in front to give a better view of the track, and this arrangement involves placing the firebox at the front of the boiler and using oil fuel.

The speeds attained by the Diesel-electric high-speed railcar on the Berlin-Hamburg line can be obtained quite economically by a light steam train. Thus, the 4-6-2 express locomotive, Series 03 of the German State Railways, has repeatedly hauled a three-coach train on the Berlin-Hamburg route with only 10 minutes extra journey time, compared with the schedule of the Flying Hamburger. For maximum economy in such steam service, however, a special construction of locomotive and coaches is required, retaining as far as possible the simple and well-proved components of ordinary locomotive practice. Acting on this principle, the Henschel firm designed the high-speed train shown in figures 3 and 4, consisting of a 4-4-2 tank locomotive, itself streamlined and close-coupled to two streamlined coaches. This train is intended for speeds up to 160 km. (99.4 miles) an hour and, as will be seen from figure 4, the wheel arrangement comprises a four-wheeled bogie of long wheelbase, four-coupled

Fig. 3. — Light train comprising streamlined steam locomotive and double coach, designed by Henschel & Sohn A.G., Kassel. The locomotive can be used at either end, and is intended for speeds up to 100 m.p.h.

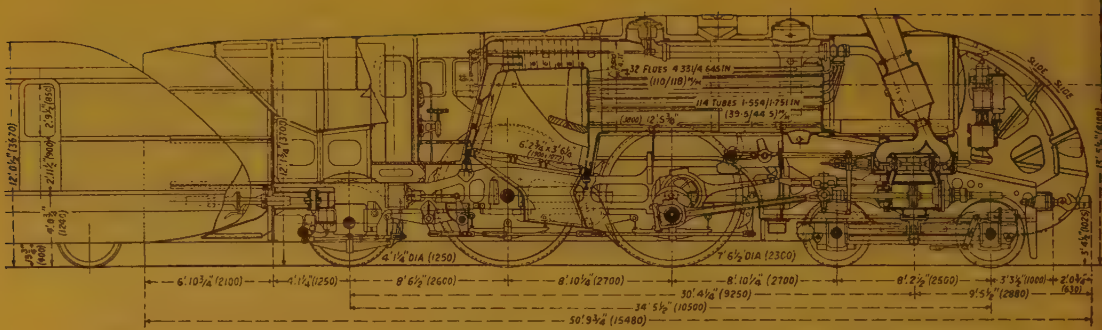


Fig. 4. — Sectional view of streamlined tank locomotive with inside cylinders and 7 ft. 6 1/2 in. diameter coupled wheels for high-speed service.

driving wheels of 2 300 mm. (7 ft. 6 1/2 in.) diameter, and trailing wheels capable of radial displacement. With a boiler steam pressure of 20 kgr./cm² (284 lb. per sq. in.), the cylinders can be placed inside the frames, driving on to the cranked leading driving axle. This arrangement reduces the nosing motion due to unbalanced reciprocating masses and conduces to steady running at high speeds. Inspection doors are provided to give access to the motion work and valve gear. Water is carried partly in low-mounted side tanks, the covers of which are sloped downwards to provide a clear view of the track, and partly in a tank beneath the coal bunker.

Automatic coupling gear, with brake and heating connections, is used between the locomotive and the double articulated coach; and the extended streamline sheathing at the rear of the locomotive covers the nose of the adjoining coach, thus reducing air resistance to a minimum. This device enables the locomotive to be used at either end of the double coach without affecting the aerodynamic form of the assembled train.

The double coach is mounted on four-wheeled bogies at each end, with a Jacobs bogie at the centre. It provides seating accommodation for 124 second-class passengers and contains, also, a refreshment compartment and a luggage compartment. The weight of the locomotive in running order is about 90 t. (88.6 Engl. tons) of which 40 t. (39.35 tons) is adhesive; the weight of the double coach is 65 t. (63.95 Engl. tons), and the water and coal carried suffice for 3 hours' running at about 140 km. (87 miles) per hour.

RECENT DEVELOPMENTS
IN RAILWAY PRACTICE.

[621. 43 (.493)]

410-H.P. Diesel-electric articulated express railcar of the Belgian National Railways Company.

The Belgian National Railways Company have recently carried out service trials with their first articulated Diesel-electric express railcar, which has been built by the « La Brugeoise et Nicaise et Delcuve » Company, at La Louvière, and which is now in regular service between Brussels and Ghent.

This railcar is a twin unit with two metal bodies and is streamlined; all the running gear below the frame is cased in by steel plating.

The two bodies are of all-metal construction, wood and plywood only being used in the interior lining of the bodies.

Fig. 1.

A gangway with double diaphragm is arranged between the two bodies.

The steel frame, the long side steel panels, and the composite steel and light alloys roof materially assist in strengthening up the body.

The unit as a whole is carried on 3 Görlitz type bogies with long longitudinal laminated springs. The leading bogie carries the 410-H.P. Maybach Diesel engine and the main generator; the centre bogie carries the two Siemens traction motors; the trailing bogie is a carrying bogie.

Roller bearing axle boxes of the outside journal type are fitted throughout.

The railcar has been designed to take curves of 250 m. (12 1/2 chains) radius on the running lines, and 175 m. (8 3/4 chains) radius on sidings.

The folding steps are raised and lowered automatically by compressed air when the doors are closed or opened.

The leading dimensions of this rail motor car are the following :

Overall lenth of each section	22.000 m. (72 ft. 2 in.)
Overall length of the unit	44.350 m. (145 ft. 6 in.)
Bogie centres (distance apart)	18.125 m. (59 ft. 5 19/32 in.)
Wheel base of leading bogie carrying the Maybach Diesel motor	3.500 m. (11 ft. 5 25/32 in.)
Wheel base of the middle bogie carrying the electric motors	3.500 m. (11 ft. 5 25/32 in.)
Wheel base of the trailing carrying bogie	3.000 m. (9 ft. 10 1/8 in.)
Height (over roof) above rail	3.727 m. (12 ft. 2 3/4 in.)
Overall width of the body	2.776 m. (9 ft. 1 5/16 in.)
Diameter of wheels on the tread	0.970 m. (3 ft. 2 1/4 in.)

No. of seats	2nd class	24 smoking 24 non-smoking	48, and 4 tip-up seats.
	3rd class	60 smoking 60 non-smoking	120, and 13 tip-up seats.
		Total	168, and 17 tip-up seats.
		In all	185 seats.

Fig. 2. — Driving bogie.

Tare weight of the vehicle fully equipped, but without fuel, oil, water, nor sand: about 67.4 t. (66.3 Engl. tons).

Weight in working order, with fuel, oil, water, and sand: 70 t. (68.9 Engl. tons).

Load of passengers and luggage = 15 t. (14.76 Engl. tons).

1. The bogies.

The three four-wheeled bogies are of the Görlitz type specially designed for high-speed vehicles.

a) *Leading bogie carrying the Diesel engine and main generator.* (Wheel base 3 500 m. = 11 ft. 5 25/32 in.).

The Diesel engine and the generator are each carried on a sub-frame fitted with three trunnions secured to the bogie main frame.

This bogie is fitted with the Westinghouse brake combined with hand-operated oil-pressure brakes operating 8 segments acting on brake drums fastened to the inside of the wheel centres. Axle guards and sanders are fitted at the leading end of the bogie.

b) *Centre bogie carrying the two electric traction motors.*

This 3 500-m. (11 ft. 5 25/32 in.) wheel base bogie is similar in design to the leading bogie, the only difference being that the two sub-frames for the Diesel motor and the generator have been replaced by special spring gear for carrying the traction motors. It also carries the articulated coupling between the inner ends of the two bodies of the unit, following the Jacobs design.

This bogie is fitted with the Westinghouse brake alone, operating 8 brake segments acting on drums on the outside of the wheel centres.

Four sand pipes are fitted: 2 at the leading and 2 at the trailing end of the bogie.

c) *Trailing carrying bogie.*

This 3 000-m. (9 ft. 10 1/8 in.) bogie is lighter than the other two, but of the same general design.

It carries no power unit, and consequently no subframe nor special spring gear. Like the other outer bogie, it is fitted with the Westinghouse brake combined with hand-operated oil-pressure brakes operating 8 segments acting on brake drums fitted to the inside of the wheel centres. Axle guards and sand pipes are fitted at the outer end of this bogie.

2. Motor equipment.

The Maybach Diesel motor develops 410 H.P. at 1 400 r.p.m. and is a 12-cylinder V. type engine with two banks of 6 cylinders with direct mechanical injection. This engine is identical with those on the express rail motor car of the German National Railway Company, operating on the Berlin-Hamburg line.

The electric drive is on the Gebus system, but with improvements intended to give better starting. The main generator develops 260 kilowatts at 850 volts maximum and 1 400 r.p.m. continuous rating. The power of each traction motor at the hourly rate is 150 kilowatts at 1 350 r.p.m., and 106 kilowatts at 725 volts and 1 520 r.p.m., continuous loading. The power at the hourly rate of the auxiliary generator is 6 kilowatts at 1 400 r.p.m., at 96 to 120 volts.

The Diesel motor is started up electrically by the main generator which acts momentarily as a motor on current from the lighting battery. The capacity of the battery is 240 ampere-hours at a voltage of 96.

The Westinghouse brake compressor is a two-stage rotary compressor with an hourly capacity of 39 m^3 (1 377 cu. feet) of free air, which it compresses to 8 kgr./cm^2 (114 ft. per sq. inch). This compressor is driven by a 6.6-kilowatt 96-volt motor taking current from the lighting and starting battery.

3. Interior arrangement.

Decoration.

a) The roofs are lined out with plywood face veneered with avodire wood with dark cross bands in the 2nd class, and with clear limba in the 3rd class.

b) The inside partitions of the second-class compartments and the vestibules are lined out with moiré - grained bubinga face veneered plywood with lighter borders and with bubinga mouldings. In the 3rd-class sections and vestibules the plywood is faced with dark bubinga, the latter wood being used for the mouldings.

(These special woods are obtained from the Belgian Congo.)

Fig. 3. — 2nd-class compartment.

Seats.

The seats and backs in the 2nd-class have spring fillings of the Simmons type, each spiral spring being encased in a calico bag; they are upholstered in special fabric. The 3rd class seats are built up of dark limba panels on oak framing.

In both classes the chair legs and hand grips are metal chromium plated.

Tip-up seats.

In the 2nd-class vestibules, the tip-up seats are upholstered and finished like the 2nd-class seats. In the 3rd-class sections ordinary tip-up seats are fitted.

Blinds.

All the windows in both the 2nd and 3rd-class compartments have imitation leather balanced roller blinds.

Fig. 4. — 3rd-class compartment.

Metal fittings.

The door handles, tread plates, parcels racks, heat regulators, etc., are chromium plated. The other metal fittings are polished white metal.

Window frames.

The frames are made of anticorodal metal bright polished on both sides. The top half of the frame is arranged to slide horizontally.

Centre ceiling panel.

The centre of the ceiling in all the compartments and vestibules is recessed and lined with brass which is chromium plated over nickel and acts as a reflector. In order to diffuse the light flat discs of glass, partly satin finished, are suspended from this recess in line with the middle of the lamps, the lower half of which projects through them.

Roof.

The turn down of the roof is covered with aluminium sheet 1 1/2 mm. (0.059 inch) thick; the centre part is built up of poplar plywood covered with impregnated canvas.

Doors.

The entrance doors, of composite steel and wood construction, have Kickert locks. The doors into the vestibules and the front windows of the driving compartment are fitted with « Splintex » glass.

Lavatories.

The fittings in each of the two lavatories consist of a flushing hopper, a wash basin, a mirror, a hathook, a commode handle and a towel rack. The floor consists of a granito slab.

Heating.

The rail coach is heated by hot water. Two Ideal Classic stoves buring 30 $\times$ 50 mm. (11 3/4 $\times$ 15 3/4 in.) anthracite nuts are fitted, one in each body. The circulating pipes are made of aluminium. A motor pump is fitted in each unit to improve the circulation of water through the pipes.

Ventilation.

« Bob » ventilators are fitted in the body side top panels over the side lights.

Lighting.

The coach is lighted electrically. There are six 75-watt lamps in the 2nd class, seventeen 60-watt lamps in the 3rd, and fourteen 25-watt lamps at various points. The lamp voltage is 96 at the battery terminals.

The results of the first trials have been most satisfactory. In the course of the trials on the 20th and 23rd April, the empty railcar covered the distance of 52 km. (32.3 miles) between Brussels Midi and Ghent St. Peter in 28 minutes, i.e. at an average speed of 111 km. (69 miles) an hour, the result of maximum speeds of 130 to 140 km. (81 to 87 miles) at different places, with the Diesel motor running at its normal speed.

As was anticipated during these trials, the rail motor car, when loaded, now covers regularly the Brussels-Ghent run in both directions in 31 minutes, i. e. at an average speed of 100 km. (62 miles) an hour.

MISCELLANEOUS INFORMATION.

[625. 215]

1. — New design of carriage bogie on the J. G. Brill system.

The form of construction used by the J. G. Brill Company for its new railway bogies would appear to give valuable results from the point of view of the riding qualities of the coaches.

A certain number of these bogies are already in service and others under construction at the present time. They are the result of several years study and have been improved and perfected as the result of tests carried out on various railways.

In addition to the details used in bogies of similar forms of construction, new improvements have been added as they have been built, and the whole of these have been incorporated in the most recent type BF 10 bogies of the French Brill Company, which has protected them by patents.

The first step was the modernisation of an old Brill bogie of the 27 E type which, up to some 25 years ago, was the standard Brill bogie for heavy traction. This bogie, for example, was used in France on the single-phase motor coaches of the Midi Company, built in 1919.

This modernisation consisted in modifying, to a patent of the builder, the suspension of the body bolsters which transmit to the solebars, close to the axle box guides, the load carried on the bogie centre, and in introducing into the construction of these bogies the arrangement of variable-flexibility springing, of guiding and transmitting the movement of the vehicle to the body bolster, characteristic of the Brill designs.

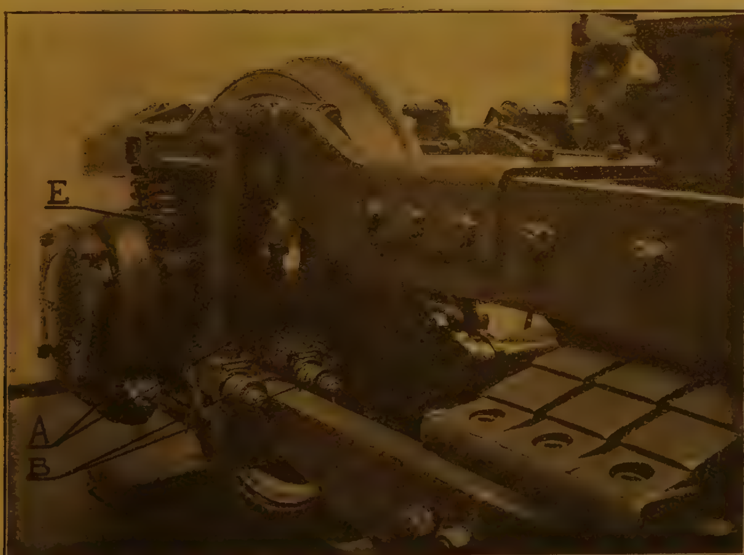


Fig. 1. — Details of the springing, type BF10 Brill bogie.
(The variable-flexibility spring gear is hidden behind the sole.)

A = Suspension link. — B = Adjustable device for damping out transverse movements. — E = Spherical bearing seat for the set of springs on the axle box.

In these bogies, equal distribution of weight as between the axle journals has been obtained, not as is most usual in similar stock by means of coiled springs and equaliser levers resting directly on the axle boxes and which form a considerable unsprung weight but, as will be shown below, by the frame of the bogie itself. This frame is supported on the axle boxes by means of coiled springs which take no part in equalising the load, and the unsprung weight is consequently reduced to a minimum.

If equal distribution of the loads on the journals can, with these bogies, be obtained to some extent through the frame of the bogie, it is due to the form of construction of the bogie lending itself particularly well to this, and also to the equal distribution of the load on the bogie centre being already properly provided for at the points where this

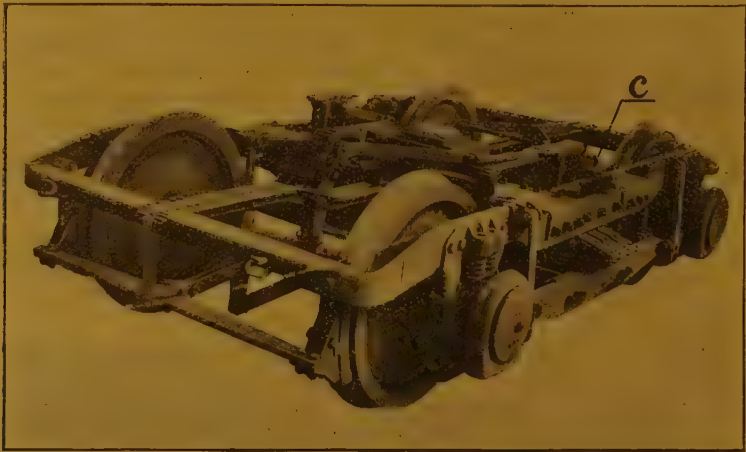


Fig. 2. — A general view of a BF10 bogie (6 trailer coaches, Class C 1001, weighing 29 tons, of the Nord Milano Railway.

C = Link guiding and entraining the bogie bolster.

load is transmitted to the solebars, as closely as possible to the journals, through members which, starting from the centre, can be considered as being all carried on simple supports (figs. 1 and 2).

The mean features of these bogies are therefore the following :

— maximum longitudinal stability due to the bogie frame being elastically supported on the axle boxes by coiled springs above these boxes ;

— maximum transverse stability, as the springs forming the elastic suspension of the body bolster can be made the maximum distance apart in the transverse plane (fig. 3), the parts suspending them from the bogie frame not being carried by the middle cross bearers of the frame but being secured to the solebars themselves (figs. 1 and 2) ;

— weight equally distributed between the axle journals as mentioned above;

— minimum unsprung weight.

In addition, with the object of improving the horizontal springing of these bogies, the makers have introduced into the pendulum suspension of their body bolster, which is already given *the longest possible swing links* for this reason (A, fig. 1), the arrangement shown in (B, fig. 1), by which it is possible to introduce friction, the amount of which can be adjusted as required, which friction, being added to that at the pins of this

pendulum swing gear, *completes the damping out of the transverse movements of the bolster* (fig. 1).

Experience has shown that the efficacy of these arrangements is remarkably good.

Their use may, however, have one drawback. These fittings help to brake the transverse displacements of the spring plank carrying the springs supporting the body bolster, which in its turn rests on these springs and is fastened to the body.

The result is that the effect of this damping device is transmitted to the body bolster and to the body through the springs which are in this way subjected to loads which are applied horizontally. These springs may have a greater tendency to tilt over on their seats and so cause the body to ride badly or even to get out of shape.

To overcome this defect, the Brill Company recently started to use, in conjunction with the damping devices in question, a patented arrangement for connecting the body bolster to the bogie bolster (D, fig. 3) which leaves

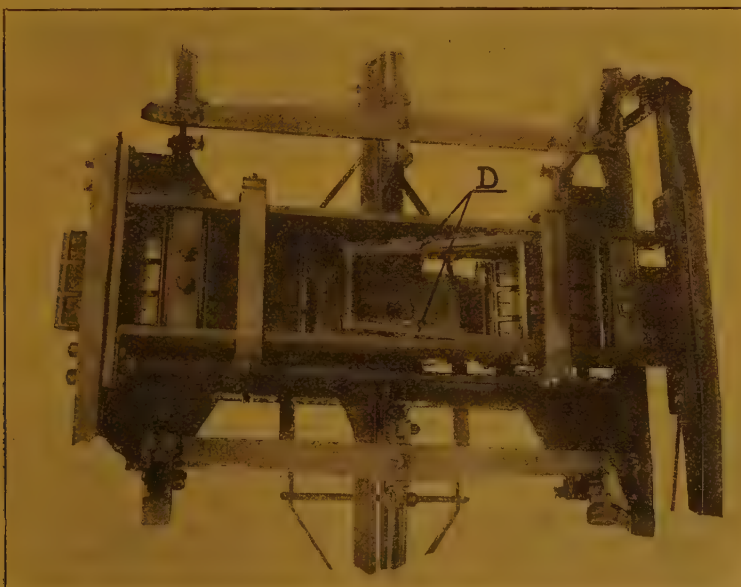


Fig. 3. — View of the bogie of figure 2, taken from underneath.

D = Connecting link by which the body bolster is made to move with the bogie bolster.

them free to move relatively one to the other in the vertical plane, but which prevents them from ever moving relatively to each other in the transverse plane.

The combination of these two arrangements — the damping device mentioned above and this transverse connection between the body and the bogie bolsters — with the device for guiding and entraining the body bolster from the bogie frame (C, fig. 2) results in the springing of the bogie bolster retaining at all times its freedom of action in the vertical direction, and in its being preserved from the effects of all parasitical forces.

We have seen that the form of construction of the frame of these bogies plays its part in equalising the loads on the journals. This is true whether the solebars of the bogies are forged with the guards or are forged solebars fitted with cast guides.

For this purpose, the details of the frame must have some flexibility in themselves, which can readily be provided because in these bogies the frame is under load at points immediately adjacent to those where it is supported by the axle box springs, and also because the different parts of the bogie are assembled together in such a way as to allow, momentarily, the whole to yield without any permanent deformation of the frame.

It may be said that, under these conditions, the coiled springs carrying the frame on the axle boxes do not take any part in equally distributing the loads, although the place available on the boxes is generally restricted; since they can only act to damp out the small oscillations due to small irregularities in the track, they can be designed so as not to be too highly stressed.

The method of construction of the BF 10

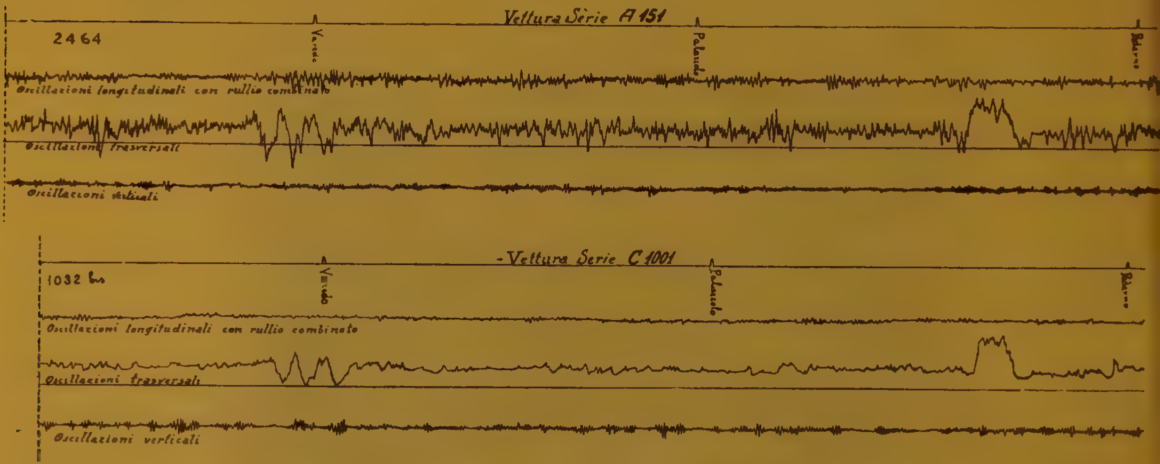


Fig. 4. — Comparative test of the running of a Class A 151 and a Class C 1001 coach of the Nord Milano Railway.

Note : Oscillazioni longitudinali con rullio combinato = Longitudinal oscillations combined with rolling.
Oscillazioni trasversali (verticali) = Transverse (vertical) oscillations.

bogies with forged solebars and with cast axle box guides (cf. figs. 1 and 2) is of particular value both as regards fitting the axle box springs and their behaviour in service.

With this form of construction, instead of there being one individual spring or a nest of concentric springs above each box, the boxes have either single springs or nests of springs grouped in pairs, or more usually in fours, on the top of the box along the axle box guide, which rests on these springs through brackets cast on the guides at the top.

The result is that for a predetermined working stress in the average coil, the metal in the smaller exterior diameter springs, and at the same time of smaller diameter section, will work under better conditions throughout the section of the coil than a spring of larger exterior diameter with greater section diameter.

Finally, in these BF 10 bogies, the springs forming these sets of springs rest on the top of the box on a seat (E, fig. 1) with a spherical base so as to be self-adjusting in order to meet any slight differences in the various springs making up each set.

These seats, besides centering the load on

each journal, have the further advantage that they allow the axle a certain liberty to move relatively to the bogie frame in the axle box guides, in a plane at right angles to the longitudinal centre line of the frame, and in the case in which one of the wheels on this axle has to pass over an appreciable difference in level.

Finally, it would appear to be possible, provided certain precautions be taken, to use in the manufacture of some of the forgings of these bogies, especially of the type BF 10, high-tensile steels such as the G steel of the French Railways standard specification, and so effect a much greater weight reduction, which would be a further valuable addition to the reduction of unsprung weight this form of construction makes possible.

Figure 4 shows the results of a comparative trial, with diagrams taken by a Hallade recorder, between two types of carriages belonging to the Nord Milano Railway (Ferrovie Nord Milano - F.N.M.). These tests were carried out during the autumn of 1933 on the Bovisa-Seveso line. The upper diagram 2464 on this figure was taken with a class A151 carriage with Fox bogies (old Sleeping Car Company pattern); the lower diagram 1032*bis* is the one taken on the same day under the same conditions with a Class C 1001 carriage fitted with BF 10 Brill bogies.

[621. 132.3 (.44) & 621. 134.4 (.44)]

2. — Compound locomotive converted to simple on the Nord Railway, France.

(The Railway Gazette.)

A year or two ago Mr. de Caso discussed the future of locomotive design on the Nord Railway, France, in a paper presented to the French Society of Civil Engineers, and forecast the carrying out of comparative experiments between compound and simple-expansion locomotives. In pursuance of these experiments two of the standard Super-Pacific locomotives of the Nord have been converted from four-cylinder compound to two-cylinder simple, and we are now enabled to illustrate and give the leading dimensions of the first of these engines, No. 3 1249. It has been equipped with two outside cylinders having the large diameter of 25 3/16 inches and a stroke of 25 9/16 inches. Distribution is by means of Cossart cam-operated valves, an illustrated description of which appeared in *The Railway Gazette* of March 17, 1933, page 383, in connection with our article on the new 2-8-2 tank locomotives, series 4 1200, which are fitted with these valves (1). Locomotive No. 3 1249 is one of the earlier series of Super-Pacific locomotives numbered 3 1201-3 1250, which were built eleven years ago. The later series 3 1251-3 1290 were placed in service about 1930 and incorporated several modifications, including an increase in the boiler working pressure from 227 lb. to 246 lb. per sq. inch, the use of large piston valves for the low-pressure cylinders, and the strengthening of the frame structure. Modified streamlining was also incorporated, and the engines now rebuilt have these characteristics also.

We give a table of the principal dimensions of the rebuilt locomotive together with those of the Super-Pacific compound series 3 1251.

(1) See also *Bulletin of the Railway Congress*, August 1933, p. 710 : de Caso, « New suburban locomotives for the French Nord Railway ».

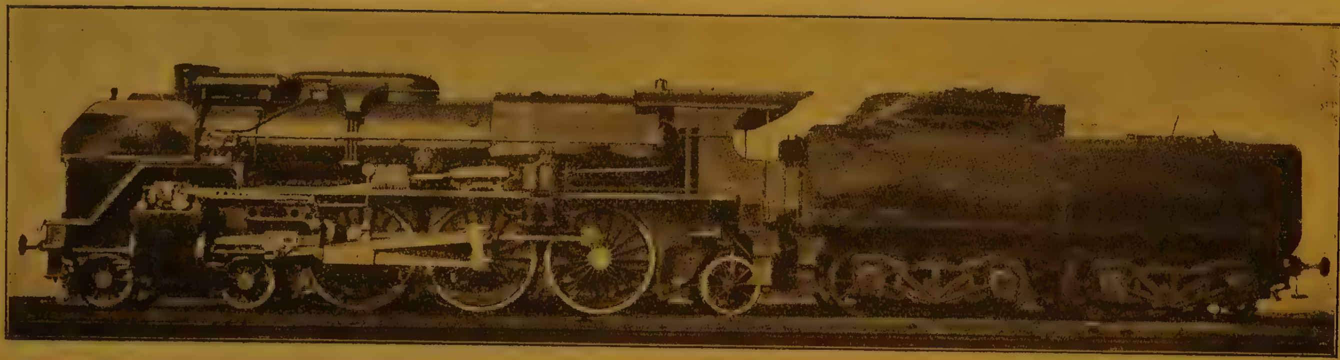


Fig. 1.

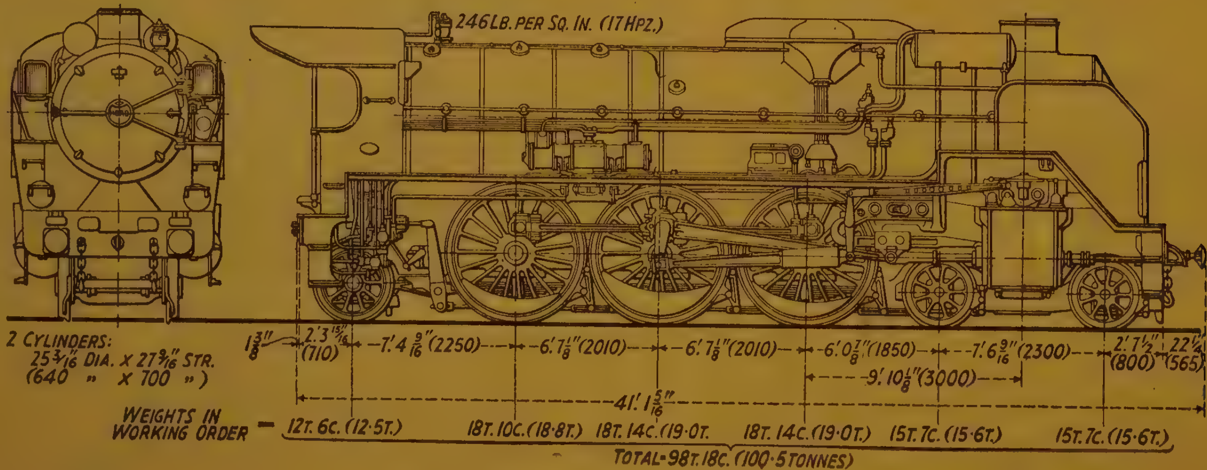


Fig. 2. — Locomotive No. 3.1249 as rebuilt.

	Two-cylinder simple, Nos. 3 1249-3 1250	Four-cylinder compound, Nos. 3 1251-3 1290
Cylinders, diam., h.p.	640 mm. (25 3/16 in.)	400 mm. (17 5/16 in.)
Cylinders, diam., l.p.	—	620 mm. (24 7/16 in.)
Cylinders, stroke, h.p.	700 mm. (27 9/16 in.)	660 mm. (26 in.)
Cylinders, stroke, l.p.	—	690 mm. (27 3/16 in.)
Coupled wheels, diam.	1 900 mm. (6 ft. 2 3/4 in.)	1 900 mm. (6 ft. 2 3/4 in.)
Bogie (or leading bissel) wheels, diam.	950 mm. (3 ft. 1 1/4 in.)	950 mm. (3 ft. 1 1/4 in.)
Trailing bissel wheels, diam.	1 040 mm. (3 ft. 5 in.)	1 040 mm. (3 ft. 5 in.)
Boiler working pressure	17 hpz. (246 lb. per sq. in.)	17 hpz. (246 lb. per sq. in.)
Boiler heating surface :		
Tubes and flues	175.68 m^2 (1 890 sq. ft.)	194.5 m^2 (2 093 sq, ft.)
Firebox	20.30 m^2 (218 sq. ft.)	20.30 m^2 (218 sq. ft.)
Superheater	66.66 m^2 (717 sq. f.)	57.2 m^2 (615 sq. ft.)
Total.	262.64 m^2 (2 825 sq. ft.)	272.0 m^2 (2 926 sq. ft.)
Grate area	3.48 m^2 (37.4 sq. ft.)	3.5 m^2 (37.7 sq. ft.)
Wheelbase, rigid	4 020 mm. (13 ft. 2 1/4 in.)	4 020 mm. (13 ft. 2 1/4 in.)
Wheelbase, total engine.	10 420 mm. (34 ft. 2 1/4 in.)	10 420 mm. (34 ft. 2 1/4 in.)
Weight of engine in working order	100.5 t. (98.9 Engl. tons)	100.5 t. (98.9 Engl. tons)
Adhesion weight	56.8 t. (55.9 Engl. tons)	56.8 t. (55.9 Engl. tons)
Maximum theoretical tractive effert : Compound	—	17 160 kgr. (37 840 lb.)
Simple.	25 825 kgr. (56 944 lb.)	23 030 kgr. (50 780 lb.)

[385. 524 (.436) & 621. 133.1 (.436)]

3. — Fuel consumption on Austrian Railways.

The coal bonus system,

by FREDERIC STRAUSS, Vienna.

(Modern Transport.)

In the case of all railways using steam for their motive power the cost of providing fuel for traction purposes forms one of the most important items in the running expenses account. It is, therefore, imperative, on grounds of economy, that measures should be adopted which will reduce the consumption of fuel to the lowest possible level. To achieve this object it is necessary, not only to put into operation well-conceived locomotive schedules, but also to make use of engines which, as well as being in good working order, are suitable to the purpose for which they are employed. It is also essential to employ good and adequate grades of coal. Even then it will only be possible to attain complete success when the engine staff is prepared to cooperate by increased personal efforts.

The object of the coal-saving bonus adopted on the Austrian Federal Railways is to arouse and maintain the personal interest of the driving staff in the economical use of fuel. The setting up of a coal-saving bonus must, therefore, be conceived in such a manner that the efforts of the crew which has been instrumental in bringing about the greatest economy shall be rewarded with an appropriate monetary payment. Thus it follows that, for proof of definite saving, there must be certain set and indisputable bases to work upon, the bonus then being calculated to correspond as nearly as possible with actual results. This calculation resolves itself into the determination of a minimum consumption, as against a quantity which is considered admissible and adequate for a given performance (the « normal requisite »). Therefore, as a groundwork for the calculation of the bonus, there is to be computed each complete operation in the train service, the actual fuel consumed in performing it, and the admissible normal requisite for this individual operation.

Coal bonus calculations.

For each ton of normal coal which, fur purposes of bonus calculation, can be proved to have been saved 5 sch. (3sh. 7d.) is paid, 60 % of this, or 3 sch. (2sh. 3d.) going to the engine-driver and 40 % or 2 sch. (1sh. 5d.) to the fireman. On account of the multiplicity of varieties of fuel used on the Austrian Federal Railways, all fuels (pitcoal, lignite, briquettes, coke, wood and fuel-oil) must, for bonus purposes, first be converted into a standard coal, designated normal coal. Normal coal is looked upon as being that coal 1 kgr. of which, when burnt in the engine-boiler, will evaporate 4.4 litres of water. For example, the conversion figure for good Northumberland coal to normal coal is 1.7, whereas for Austrian lignite the average figure works out at 0.9. The individual engine performances for which normal requisites have been worked out are as follow :

a) One locomotive-kilometre.
b) One 1 000 gross ton-kilometres.
c) One hour shunting.
d) One hour standing under steam.
e) One hour heating up a passenger train.
f) One hour disinfecting carriages.
g) One hour disinfecting carriages.

The amount of fuel for lighting up the engine is included in the normal requisite.

The normal requisites are worked out for the summer months (May to September inclusive), and during the winter months (October to April inclusive) so-called winter supplements are allowed on these figures as follow : October, 2 % ; November, 7 % ; December, 16 % ; January, 18 % ; February, 16 % ; March, 10 % ; and April, 6 %. The permissible fuel consumption for driving a train is arrived at by multiplying the locomotive-kilometres covered and the 1 000 gross ton-kilometres performed by the appropriate normal

requisite. In the case of pilot or banking work, each locomotive receives the permissible allowance of fuel for the number of kilometres covered. The 1 000 gross ton-kilometre performance is, however, divided between the individual locomotives, and the relative share to be borne by each is determined according to the proportion of the coupled axles of the locomotives doing duty with the train. The saving bonus ought, basically, to be calculated for each engine separately. As, however, it is impossible to do this without considerable difficulty when two or more crews are employed per engine, the bonus is calculated conjointly (per locomotive) in this case, and is subsequently divided amongst the individual crews serving on one and the same engine, according to their respective share in the kilometres covered by that engine.

Normal requisites.

The normal requisites are worked out in such a manner that not only is the type of individual operation (for example, express, passenger of goods traffic) taken into consideration, but also the scheduled groups. The normal requisites are ascertained for a full month's working according to schedule, and it is generally accepted that, on an average, one crew can save, in the case of express trains, at least 18 tons (on long journeys as much as 25 tons); in the case of passenger trains, 14 tons; in the case of goods traffic, 11 tons; and in the case of shunting operations (175 shunting hours), 8 tons of normal coal. In order to get correct details for calculating the consumption of coal, accurate entries (quantity and grade) are made at the coal depots on the weigh-slips of the performance-chart which each crew receives before starting on a journey.

Fixing the bonus.

For fixing the bonus, the amount of hauling and subsidiary work done, as well as the quantity of fuel delivered, are first ascertained by means of the performance chart. The data thus obtained (locomotive-kilometres and 1 000 gross ton-kilometres covered) are then entered in the log-book of the locomotive, which is arranged according to type of train and sections of line concerned, with the normal requisites entered therein. The final totals of the locomotive log-book, in which the conversion of the different fuels to normal coal is also effected, yield the basis for calculating the bonus. As an exemple, the following may be taken as an individual calculation for the crew of a goods train, the final totals of the hauling and subsidiary work done during the month being as shown in the table, and the amount of fuel used being 68.64 tons of normal coal :

Work performed.

Train-kilometres	2 392
1 000 gross ton-kilometres. . . .	401.4
Shunting hours	18
Standing under steam	26
Light kilometres	114

The calculation is worked out as follows :

Performance.		*Normal requisite.*		*Tons of normal coal.*
401.4	×	120 kgr.	=	48.168
2 392	×	11 kgr.	=	26.312
18	×	220 kgr.	=	3.960
26	×	60 kgr.	=	1.560
114	×	11 kgr.	=	1.254
Total fuel consumption permissible			=	81.254
Deduct fuel actually consumed			=	68.640
Fuel saved			=	12.614

The bonus is payable at the rate of 5 sch. per ton on the amount of fuel economised. Therefore, the bonus due to the engine crew is :

12.614 tons at 5 sch. per ton = 63 sch. 07 g. (£2 5sh.), of which sum the driver receives 60 % = 37 sch. 84 g. (£1 7sh.), and the fireman 40 % = 25 sch. 23 g. (18sh.)

The conversion of subsidiary operations into kilometres is effected by multiplying the hours taken up in shunting, disinfection of carriages, and taking in water by 10 ; the time spent in getting up steam by 5 ; and the hours standing under steam by 2.

Divided opinions.

In conclusion, it can be said that the opinions of officers of the Continental railways as to the expediency of coal-saving bonuses are divided. In the case of the Austrian

Federal Railways, however, it has been shown that, by means of such bonuses, considerable quantities of fuel could be saved. Thus, in 1923 the fuel consumption per 1 000 gross ton-kilometres amounted to 183.7 kgr. of normal coal, whereas in 1932 it had fallen to 148.2 kgr. which, in large measure, is directly due to the operation of the coal-saving bonus.

[621. 13 (.45) & 621. 43 (.45)]

4. — Recent Italian locomotives.

(Engineering.)

The decision of the Italian Government to electrify 4 400 km. (2 734 miles) of railways in Italy before 1943, and particularly the inauguration of the newly-built electric railway from Bologna to Florence, which is to take place during 1934, will increase the capacity of the lines connecting North Italy and South Italy, and will shorten the distance between the two parts of the Peninsula by about two hours. It has also rendered necessary the construction of some powerful electric locomotives for operation on the system. The first of these locomotives has been built by the Societá Italiana Ernesto Breda, of Milan, from whom the Italian State Railways Administration has ordered several others. These locomotives have the following dimensions :

Type	4—6—4.
Gauge	1 445 mm. (4 ft. 8 1/2 in.).
Current supply	3 000 volts.
Total power, one hour rating .	3 000 H.P.
Maximum speed	130 km. (80 miles) per hour.
Diameter of the driving wheels.	2 050 mm. (6 ft. 8 3/4 in.).
Total length	16 300 mm. (53 ft. 6 in.).
Total weight	122 tons.
Adhesive weight	63 tons.

The frame is carried on two four-wheeled bogies, in addition to the six driving wheels. The body consists of a central portion and two end sections, the central portion being divided into three sections, and the two end portions forming the driver's cab. These are connected by means of a lateral corridor. There are three motors of the coupled type suspended from the frame. Each of two shafts transmits motion by means of a pinion to a toothed ring mounted on a quill, which drives the wheels through an elastic transmission of the Bianchi type.

The motors, which run on direct current, absorb about 700 kw. and are each provided with auxiliary poles. The three motors can be connected in series, series-parallel and parallel, and in each of these combinations the fields can be varied so as to obtain a sufficient range of speeds.

The equipment of this locomotive includes a motor-generator set for the production of current at 90 volts. On the shaft of this set is mounted a fan having a minimum capacity of 100 m³ (3 530 cub. feet) per minute, at the minimum pressure of 100 mm. (4 inches) of water. There are also two motor-driven compressors each having a capacity of 1 000 litres (35 cub. feet) of free air per minute, a reversing gear operated by compressed air, a switchboard, a Westinghouse-Hardy system circuit breaker with high-speed and medium-speed action, etc. The high-tension gear is located in the central portion of the body.

During the trials, which have just been carried out on the Florence-Bologna line, the new electric locomotive attained a maximum speed of 140 km. (87 miles) per hour and an average speed of 120 km. (75 miles) per hour.

The successful results obtained from the electric locomotive above referred to have directed attention to the progress of the Italian locomotive industry, which recently built for the Italian State Railways steam locomotives

of the Mikado and Pacific types. The Mikado-type locomotive appeared in 1921, the first engines being built by the Societá Italiana Ernesto Breda, of Milan. Even before that time there were in service in Italy some locomotives with a similar disposition of axles, but they were all tank locomotives, and, consequently, were only employed on branch lines. The present Mikado-type locomotives, on the other hand, are employed for high-speed heavy traffic. These locomotives are of the four-cylinder compound type, with two internal high-pressure cylinders and two external low-pressure cylinders. They are provided with superheaters, since they are required to draw heavy trains for long distances without a stop. They have four coupled axles with wheels 1 880 mm. (6 ft. 2 in.) in diameter, a front axle forming with the first coupled axle the so-called Zara truck, and another rear axle

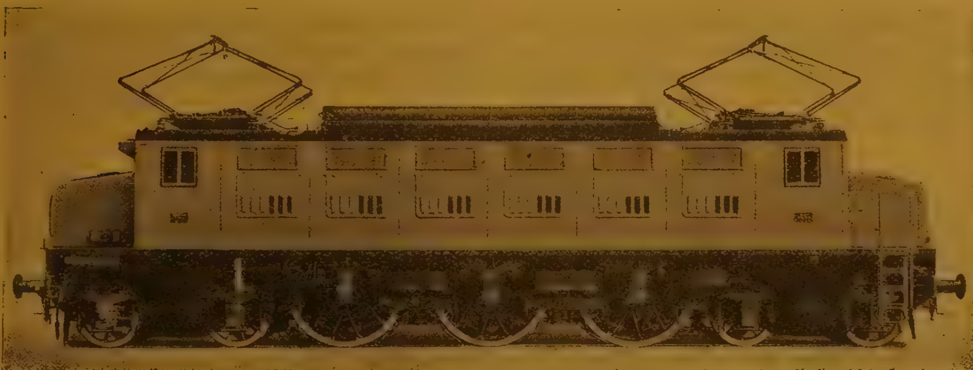


Fig. 1. — 4-6-4 type electric locomotive, Italian State Railways.

of the Bissel type. These locomotives can develop a normal effective power of 1 600 H.P. and can attain a maximum speed of 100 km. (62 miles) per hour.

The steam locomotives recently constructed of the Pacific type have also been built by the Societá Italiana Ernesto Breda, of Milan, as well as at the works of the Italian State Railways Administration, at Florence, during the latter part of 1932 and the early part of 1933. Such locomotives have been developed from earlier locomotives of the same type, a boiler of larger capacity having been fitted, and also a rear axle of the Bissel type as in the Mikado-type locomotives. These locomotives work at the comparatively high pressure of 16 atmospheres (236 lb. per square inch), with superheated steam and have four simple cylinders. They have three coupled axles with wheels 2 030 mm. (6 ft. 8 in.) in diameter, a front four-wheeled bogie, and rear axle of the Bissel type, as previously mentioned. The normal power of these locomotives is about 1 800 H.P., and the maximum speed is 120 km. (75 miles) per hour. These locomotives are fitted with Knorr-type superheaters and with forced lubrication. An interesting development in the locomotive industry of Italy is the extensive employment of the Caprotti poppet valve.

[621. 335 (.43) & 621. 43 (.43)]

5. — 64-B.H.P. Henschel petrol loco-tractors with electric transmission on the Gebus system.

(*The Railway Engineer.*)

The accompanying illustration and general arrangement drawing show the principal features of the latest type of Henschel petrol-electric locomotive, rated at 64 B.H.P. and recently tested by the research department at the Grunewald repair shops of the German State Railways with highly satisfactory results. The locomotive is of the four-wheeled type, each axle being chain-driven by the same electric motor. The axles run in roller bearings, and the steel plate frames are carried by three-leaf springs attached to the axleboxes and brackets on the frames.

A sheet-metal bonnet encloses the petrol motor and electric generator, large doors being provided in each side and on the top for inspection purposes. If necessary, the entire bonnet can be taken off, to allow the engine or generator (or both) to be removed without disturbing other parts. The radiator for cooling the circulating water is mounted across the front of the bonnet in the usual way.

Fig. 1. — Petrol-electric loco-tractor with 64-B.H.P. petrol engine and electric transmission on the Gebus self-regulating system.

Large windows are provided in the front and back of the driver's cab to give a good view of the road. The floor is dropped at each side so that the driver can step into the cab without the aid of a projecting footboard. A box-like enclosure in the cab contains the starting and lighting battery, the reversing controller and tools. The driver's controls are in duplicate, so that the locomotive can be driven from either side of the cab, and comprise only reversing levers and the handwheels for regulating the fuel supply to the engine.

Pedal-operated brakes are provided, acting on all four wheels with a pressure equal to 60 % of the weight of the locomotive in running order. The rodding is compensated and adjustment is effected from the cab. The coupling and buffer gear are attached to very substantial cross bracings between the main frames, and the automatic coupling is actuated by means of a pedal in the driver's cab.

Power unit.

The prime mover is a four-cylinder, four-stroke engine as built by Henschel & Sohn

for use in commercial road vehicles, operating on petrol or benzol. The cylinders are 120 mm. diameter by 160 mm. stroke, cast *en bloc,* and developing the rated output at 1 200 r.p.m. The interchangeable admission and exhaust valves are of the overhead type, mounted in a detachable cylinder head and operated from the camshaft by rollers, push rods and rocking levers, the whole of this gear being enclosed by a detachable aluminium cover. The intake passages are cast in the cylinder head so that even in the coldest weather good vaporisation of fuel is secured and the power output is fully maintained. This arrangement offers the further advantage that the engine runs equally well on a wide range of fuels.

The crankshaft and connecting rods are of chrome-nickel steel, with case-hardened crank pins, and the pistons are of light metal. A centrifugal governor limits the maximum speed of the motor by actuating a throttle in the induction pipe. Cooling is effected with the aid of a centrifugal pump and a belt-driven fan, and forced lubrication is maintained by an oil pump driven from the camshaft. A Bosch combined ignition and lighting unit is employed, the lighting dynamo and ignition magneto being mechanically combined but electrically independent. Starting is by electric battery. If desired, a Diesel motor can be used instead of a petrol engine.

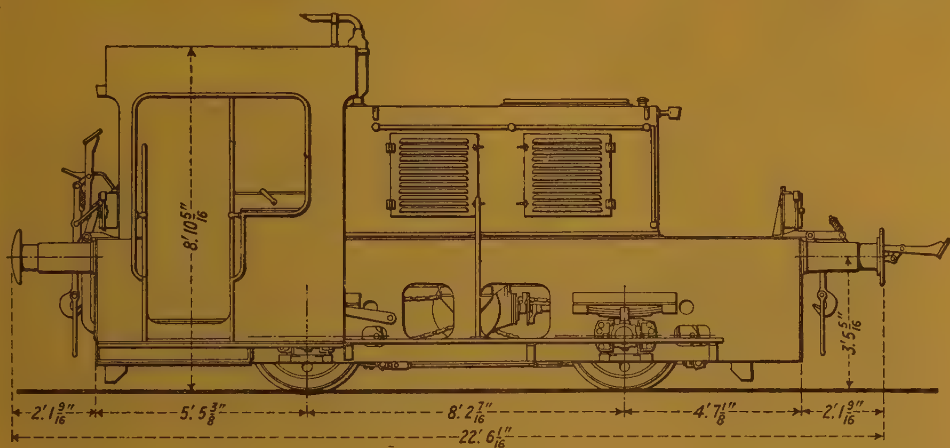


Fig. 2. — General arrangement and leading dimensions of petrol-electric shunting locomotive by Henschel & Sohn A.G., Kassel.

Control and electric transmission.

The engine drives a direct-current shunt-wound generator through a flexible coupling, and the current generated is taken, through a reversing switch, to the traction motor which drives the axles by means of double chains. The driver has no rheostat or controller to manipulate, or instruments to read, but is required simply to set a reversing switch to determine the direction of running of the locomotive, and then to turn the handweel regulating the fuel supply to the engine. Interlocks are provided so that the reversing switch can only be operated when the throttle handwheel is in its slow position, the engine then running light and the generator speed being below that required for self-excitation. When the locomotive is to be started, the driver first sets the reversing switch for forward or reverse running, as the case may be, and then slowly turns the handwheel, opening the throttle. This in-

creases the speed of the engine and generator and, therefore, raises the voltage applied to the traction motor. As soon as the motor current is sufficient to overcome the tractive resistance, the locomotive starts smoothly from rest, and acceleration proceeds uniformly and continuously as long as the speed of the engine and dynamo increases.

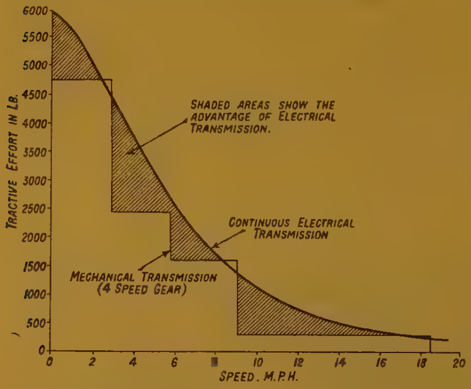


Fig. 3. — Tractive effort-speed curve of Henschel petrol-electric shunting locomotive, compared with stepped diagram corresponding to four-speed geared transmission.

The actual running speed always adjusts itself automatically to the gradient and load, without any attention on the part of the driver, it being a distinctive feature of this, the Gebus system of control, that the voltage-current characteristic of the electrical transmission is of the constant-power type. Subject always to the master-control of the engine governor, which prevents racing, the power unit and transmission—and therefore the locomotive itself—automatically accelerate to the speed corresponding to best utilisation of the engine output. If the tractive resistance is increased, whether by gradients, curves or coupled load, the speed decreases automatically; and, conversely, the speed increases as the tractive resistance decreases.

These characteristics are shown in the accompanying diagram, which also indicates the advantage of the continuous tractive effort-speed curve provided by the electrical transmission, compared with the four steps provided by a typical mechanical change-speed gear. The difference between the two characteristics is shaded in the diagram, and it will be seen that the electrical transmission makes available a substantially higher tractive effort, not only at starting, but at almost every speed. The automatic and continuous variation of speed with the tractive effort required greatly reduces wear and tear in the engine and transmission ; and the fuel consumption is reduced to a minimum by the full utilisation of the engine capacity.

Test results.

In the course of a series of trial runs one of these locomotives developed a maximum starting effort of 3 750 kgr. (8 269 lb.) at the drawbar and ran light at 36-7 km. or 22-8 m.p.h. When running on the Nauen-Wusternmark line with a dynamometer car and a number of braked goods wagons as load, the performance was as follows:

Speed.	5-6 km. (3-48 miles p.h.)	10 km. (6-2 miles p.h.)
Engine output	49-5 C. V. (48.8 H. P.)	60 C. V. (59.2 H.P.)
Engine r.p.m.	900	1 090
Drawbar horse-power . . .	34.5 C.V. (34.0 H.P.)	40 C.V. (39.5 H.P.)
Tractive effort	1 650 kgr. (3 638 lb.)	1 080 kgr. (2 381 lb.)
Fuel consumption	246 gr./C.V.-hr. (0 548 lb./ H.P.-hr.)	215 gr./C.V.-hr. (0.479 lb./ H.P.-hr.)

From a series of load-speed-gradient curves prepared by the Henschel & Sohn A.-G., it appears that a locomotive of this type is capable of hauling a train of 500 tons on straight level track at 4 km. (about 2 1/2 miles) an hour, and up to 175 tons at lower speeds on a gradient of 1 in 100. With a trailing load of 260 tons the locomotive will maintain a speed of 10 km. (6 1/4 miles) an hour on the level.

In general, it is claimed that this type of locomotive, with either petrol or Diesel en-

gine, as may be more convenient, offers a maximum of reliability and economy, combined with the simplest possible operation, and automatic adjustment of running speed to suit all variations in load.

[621. 392 (.42)]

6. — A portable Diesel-electric welding plant.

(The Railway Gazette.)

Apart from the cost of labour and of the electrodes used in building up worn railway crossings by electric arc welding, petrol cost is the highest individual item involved and probably runs to something between 9d. and 1sh. an hour. The importance of a Diesel-electric set lies in its very much lower cost for fuel, probably in the neighbourhood of 2d. to 2 1/2 d. an hour. G. D. Peters & Co. Ltd., of Slough, have now brought out such a set, and it has been working successfully for some weeks on the Great Western Railway. It has been designated a Plastic Arc « S » type plant, and besides the main generator for welding, has an auxiliary dynamo for the grinding outfit, so that welding and grinding may proceed simultaneously.

The generator is a screen protected droo-

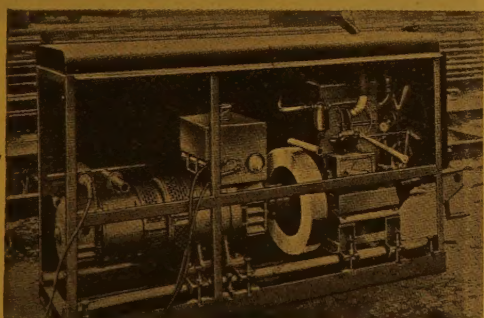


Fig. 1. — Diesel-electric welding set ready for use.

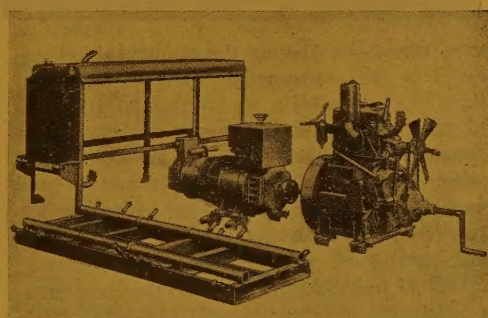


Fig. 2. — Set dismounted for transport by hand.

ping characteristic machine, with endshield type ball and roller bearings and has a welding range of from 30 to 200 amperes at an open circuit voltage of 55 volts, drooping automatically to the required arc voltage according to the electrode used. It is directly connected to the engine by a flexible pin type coupling. The grinding generator is similarly coupled to the main generator by means of a special butt type coupling and flange mounting. The grinding generator is of 2 kw., 220 volts. The two-cylinder engine is an Ailsa Craig light-weight Diesel developing 16-H.P. at 1 440 r.p.m. It has thermo-syphon cooling. A Bosch fuel injection pump and nozzle are fitted to the engine, and the cylinder block and crank case are of Birmabright alloy. The former is fitted with wet type Nitralloy liners. The engine starts easily from cold and runs smokelessly on load. A shunt field regulator designed to give close adjustment of the generator voltage, and a 0-80 voltmeter are mounted on a light metal box fitted over the welding generator. A light portable control box is also provided for the welder.

A 1 1/2-H.P. grinding motor drives the grinding wheel through a rubber sheathed flexible steel shaft. The standard grinding head is fitted with a guard for the grinding wheels.

The main bedplate consists of seven light

steel channels, to which are welded two steel tubes carrying the engine and generator. This bedplate, although light, is so rigid as to ensure perfect alignment. An angle iron superstructure is provided so that the machine is completely covered with a sheet steel roof, and may be enclosed by detachable sheet steel side and end doors arranged to interlock so that they can be secured by means of one padlock.

Fig. 3. — Moving the dimounted set to another site.

Fig. 4. — Welding a worn crossing in progress.

The machine can be dismantled into four pieces, each capable of being handled by six men, and reassembled in three minutes, hand nuts being provided so as to eliminate the necessity for many tools. One of our illustrations shows how the plant separates up for transporting to another site. This is believed to be the first dismountable Diesel welding set.

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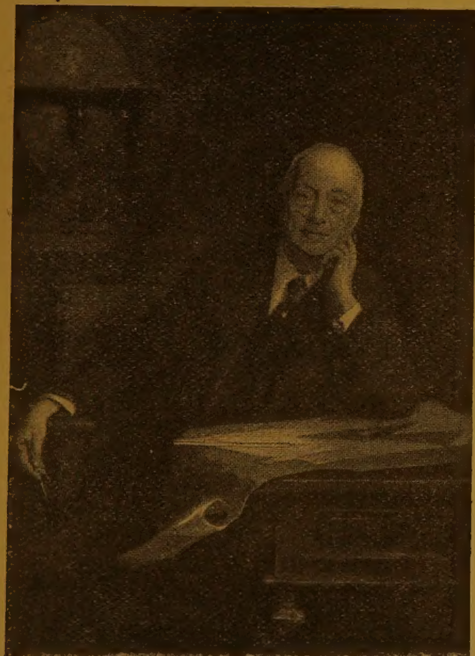
OBITUARY.

Sir Frederick PALMER,

K. C. M. G., C. I. E., M. Inst. C. E., etc.

Member of the Permanent Commission of the International Railway Congress Association.



From a portrait by Mr. Philip de Laszlo at the Institution of Civil Engineers.
(Modern Transport.)

We regret to record the death on April 7, of Sir Frederick Palmer, K. C. M. G., C. I. E., M. Inst. C. E., etc., Senior Partner in the firm of Rendel, Palmer and Tritton, consulting engineers, Westminster. Born in 1862 and educated at Neath, he became later an articled pupil on the Great Western Railway.

In 1883, he left the Great Western Railway to take up the position of assistant engineer to the East Indian Railway, and in the service of that company he constructed the largest bridge in India, that over the River Sone. After eighteen years with the East Indian Railway, he was appointed chief engineer to the Calcutta Port Authority, which position he vacated, in 1909, in order to become chief engineer to the Port of London Authority, then newly constituted under Act of Parliament. In 1913, he retired to become a partner in the firm of Rendel, Palmer and Tritton, consulting engineers to the Government of India and most of the Indian railways, and was subsequently closely associated with several most important public works in all parts of the Empire. For instance, in 1922, he was commissioned by the Crown Agents for the Colonies, on behalf of the Government of the Mandated Territory of Palestine, to report on the question of providing a harbour for Palestine, his recommendations being adopted in June, 1927, and his firm appointed consulting engineers for the construction of Haifa Harbour, which was officially opened by the High Commissioner for Palestine in October, 1933. In 1925, he was appointed, as consulting engineer, to take charge of the improvement works decided upon by the Port of London Authority, including a new entrance lock and other works at the West India Docks, a new entrance lock at Tilbury Docks, a new dry dock, and the Tilbury floating landing stage, which was opened in May, 1930. In 1927, he visited Hudson Bay at the invitation of the Government of Canada, and advised the adoption of Port Churchill as a harbour for the Bay, whilst in 1928 he was consulted on the design for the new £ 10 000 000 terminal station for the Canadian National Railways at Montreal.

Early in 1929 his firm were appointed consulting engineers for the bridge over the River Hooghly at Calcutta, and in conjunction with Livesey and Henderson, are consulting engineers for the bridge now being built over the Lower Zambesi River to give direct railway access to Nyasaland. In 1928, the firm of Rendel, Palmer and Tritton were entrusted with the construction of the Victoria Docks Road improvement works, and in March, 1933, were appointed by the London County Council to be the engineers responsible for the reconditioning and corbelling-out of Waterloo Bridge, which work is now to be held in abeyance due to the decision of the newly-elected London County Council to urge the Government to sanction a grant of 60 % of the cost of building a new bridge. Sir Frederick Palmer, who was president of the Institution of Civil Engineers in 1926-27, was created a Companion of the Order of the Indian Empire in 1907 and a Knight Commander of the Order of St. Michael and St. George in the King's Birthday Honours List of 1930. He was a Colonel of the Engineer and Railway Staff Corps.

Since 1930, he was the representative of the Government of India on the Permanent Commission of the International Railway Congress Association.

We wish to convey our sincere sympathy of this family.

The Executive Committee.